Modeling Melodic Dictation

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Contents

Chapter 1

Significance of the Study

All students pursing a Bachelor's degree in Music from universities accredited by the National Association of Schools of Music must learn to take melodic dictation (Nat, 2018, Section VIII.6.B.2.A). Melodic dictation is a cognitively demanding process that requires students to listen to a melody, retain it in memory, and then use their knowledge of Western musical notation in order to recreate the mental image of the melody on paper in a limited time frame. As of 2018 there are 647 Schools of Music belonging to National Association of Schools of Music (NASM) CITE WEBSITE, meaning that hundereds of students every year will be expected to learn this challenging task as part of their Aural Skills education. The logic being that as one improves in their abiliy to take melodic dictation, this practice of critical and active listening develops as a means to improve one's ability to "think in music" and thus become a more compotent musician. While learning Aural Skills has been a hallmark of being educated within the Western conservatory tradition, the rationale behind both the how and why of aural skills is often thought of as being esoteric. Throughout the past century, people have disagreed on exactly how one does go about learning a melody with different areas of research each attacking the problem from a different angle.

Despite its ubiqiquity in curricula within School of Music settings, research on topics pertain to how aural skills are acquired is limited at best. The fields of music theory and cognitive psychology are best positioned to make progress on this question, but often the skills required to be well versed ein ither of these subjects are disparate, published in other journals, and the research with overlap is scarce. This problem is not new and there have been repeated attempts to bridge the gap between practioners of aural skills and people in cognitive psycholgy CITES. Literature from music theory has establisehd conceptual frameworks regarding aural skills Karpinski (2000) and the relavint cognitive psychology literature has explored factors that might contribute to melodic perception (SCHMUKLER SYNERR 2016 2016), and there exists applied literature from the world of music education (CITES).

However, despite these siloed areas of research, we as music researchers do not have an a concrete understanding of exaclty what contributes to HOW individuals learn melodies (HALPERNBARLETT2010). This is peculiar since "how does one learn a melody" seems to be one of the fundamental questions to the fields of music theory, music psychology, as well as music education. Given this lack of understanding, it becomes even more peculiar that this lack of convergence of evidence is then unable to provide a solid baseline as to what student in their aural skills classrooms can be expected to do. (Also something about we should really know this if we are going to grade people on this ability). While no single dissertation can solve any problem completely, this dissertation aims to fill the gap in the literature between aural skills practitioners (theorists and educators) and music psychologists in order to reach conclusion that can be applied systematically in pedagogical contexts. In order to do this I draw both literatures (music and science) in order to demonstrate how tools from both cognitive psychology as well as computational musicology can help move both fields forward. Some line here about if we really want to understand what is happening we need to know about causal factors going on here and have experimental manipulation and things like making models of the whole thing. Great to rely on some sort of anecdoatal evidence, but if we are going to put things on the line with our education then we need to be able to make some sort of falsifiable claims about what we are doing. Can

only do that through the lens of science.

1.1 Chapter Overview

In this first chapter, I introduce the process of melodic dictation and discuss factors that would presumably could play a role in taking melodic dictation. The chapter introduces both a theoretical backgorund and rationale for using method form both computational musicology and congitive psychology in order ot answr quesitona bout how individuals learn melodies. I argue that tools for understanding this best because as we currently understand it, I see us operating in a Kuhnian normal science where much can be learned by just using the tools in front of us. This chapter will clearly outline the factors hypothesized to contribute to an individual's abilit to learn melodies, incorporating both individual and musical parameters. The chapter ends with a discussion some of the philosophical/theoretical problems with attempting to measure thigns like this (is it just a party trick?) and establishes that I will be taking a more polymorphic view of musicianship in order to answer this question.

The second chapter of my dissertation focuses on the history and current state of aural skills pedagogy.

Tracing back its origins to the practical need to teach musical skills back with Guido d'Arezzo, I compare and contrast the different methodological approaches that have been used, along with their goals.

The third chapter discusses previous work that examines individual factors thought to contribute to one's ability to perform an aural skills task, and it will discuss results from an experiment contributing to a discussion of how individual differences could contribute to how a person learns melodies.

Turning away from individual differences and focusing on musical features, in the fourth chapter I plan to discuss how music researchers can use tools from computational musicology as predictive features of melodies. Inspired by work from computational linguistics and information theory, recent work in computational musicology has developed software capable of abstracting features thought to be important to learning melodies, such as note density and 'tonalness' (Müllensiefen, 2009). Talk a bit about how this has been also looked at before in the music education community.

While these features have been used in large scale, exploratory studies, work in this chapter will discuss how these features could be used in controlled, experimental studies as a stand-in for the intuition many music pedagogues have when determining difficulty of a melody in a classroom setting.

In my fifth chapter, I introduce a novel corpus of over 600 digitized melodies encoded in a queryable format. This dataset will also serve as a valuable resource for future researchers in music, psychology, and the digital humanities. This chapter begins with a discussion of the history of corpus studies, noting their origin outside of music, their current state in music, and their limitations. This chapter, encapsulating the encoding process, the sampling criteria, and the situation of corpus methodologies within the broader research area, will go over summary data and also talk about how it could be used to generate hypotheses for future experiemnts (n-gram stuff based on patterns) .

Lastly, in the final chapter, I will synthesize the previous research in a series of melodic dictation experiments. Stimuli for the experiments are selected based on the abstracted features of the melodies and are manipulated as independent variables based on the previous theoretical literature. I then model responses from the experiments using both individual factors and musical features in order to predict how well an individual performs in behavioral tasks similar to some of my previously published research (Baker & Müllensiefen, 2017). Here I also note important caveats in scoring melodic dictation, referencing some other of my own work on using metrics, such as edit distance (Baker & Shanahan, 2018), to discuss similarities between the correct answer and an individual's attempts at dictation. Results from the final chapter will be discussed with reference to how findings are applicable to pedagoges in aural skills settings. Recommendations will be made building on current conceptual frameworks (Karpinski, 2000).

Chapter 2

Theoretical Background and Rationale

2.1 Theoretical Background and Rationale

As stated above, melodic dictation is a hugely complex process.

What am I going to do in this chapter? + Intro to aural skills and melodic dictation + Talk about the factors that go into it (basically real time suduko) + Cognitive + Musical + Note that reserach is messy, need to think of it polymorphically

Even anecdoatal evidence suggests that people who are good at this tend to stay good and people who are bad at it tend to stay bad

Other things that I might not want to bring up right now is that a lot of this could just be thought of as relating to a big thought experiemnt where you could imagine that there are many musicians from lots of different muscial cultures (bring in the ethnos!) that could imagine being sucessful at what they do without having this ability to take melodic dicatation. Is it just a party trick? Also here would be a good place to jump off of and talk about the lack of transfer.

Where do people learn it? – Music school Part of large thing of aural skills Absoulte ubiquity, but for the amount that it is done, relatively understudied

Not only is this process intenstive, but also ubiquitous

2.2

Karpinski (2000) schematizes this ability into a four step process of hear, remember, understand, notate (See Figure 1?).

While Some researchers have estimated that XX amount of processes are needed to sucessfully execute this task FIND CITATION.

– Should be drawing here from ICMPC paper?

2.3 Order of Chapter 1

- Hook on why this is important

- What is melodic dictation?
  - Process (reasons of why factors)
  - Who has talked about it before?
  - Why is it important – training ear and transfer
- Most of the people who are talking about this are pedagogical, really it's perceptual
- Here is huge list of literature of things that might contribute
  - Pedagogical factors
  - Cognitive Factors
  - Musical Factors
  - All of these are moving parts, need better tools to describe
- While this is the narrative, does not conform to updated view of polymorphism of musicianship

2.4 Order of Chapter 2

- Most of this literature comes from pedagogy
- All quotes about people should be able to do this
- Long history of Aural Skills
  - Older people
  - Current Methods
  - Their goals
  - Their assumptions
- People are not good at this
  - Wennerstronm (1989) said people at IU are not good at aural skills and sight singing p.163 (k7)
  - Julliard (1953,p. 48) incoming students have untrained ear (k7)
- nice quote from chittum 1967 "the da is past when teachers can say, you either have it or you don't" (p.73)
- Start of a big Journey back then, even more now (almost 2 decades since Karpinski, 2000)

2.4.1 Theoretical Background

Lots of older studies looking at this listed on page 2 of Taylor and Pembrook 1983 (List here)

2.4.1.1 Computational Musicology

2.4.1.2 Music Psychology and Memory for Melody

2.4.2 Rationale

2.4.2.1 Computational Musicology

2.4.2.2 Music Psychology

2.4.3 Factors

This section will list factors that are believed to be important to modeling melodic dictation. Need to have both individual and musical parameters. Ends with polymorphic view of musicianship. + Nichols, Wolner, Halpern 2018 + Niels paper on Jazz similarity + My paper on Wagner

++++++++++++++ Pitch in Karpinki

- Pitch Matching (Work being done with Seatle, Pfordresher)

- Pitch Memory (See Snyder)
- Pitch Collection and Chunking
- Infereing Tonic
- Melodic Contour
- Scale Degrees
- Identification of Intervals
- Identifcaiton of Scale Types
- Solimization Systems
- AP

++++++++++++++++++++ Melodic Dictation

Kraft 1999 – First part of book is for melodic dictation Benward and Lolosick 1996a – Melodic Dictation

Karpinski 1990 Has its own model for melodic perception??

Page 66 of K – Relevant Melodic Contour Information page 68 of K – Deutsch – Familiar systems are better (now we have IDyOM) Dowling and Harwood 1986 124-44 Melodic expectancy (probably better for Pearce) READ Sloboda and Parker 1985

THURSDAY FOLLOW UP! Follow Ups of Note Max + Tallarico 1974 + Long 1977 + Pembrook 1983

7-11 Notes? Marple ND reports that most things land in 7 +/-2, But not mention of IC! Found that if you make it rhythmic, goes up to 6-10, rhythm helps, but maybe it's just shorter time

Potter 1980 – most people chunk (obvs question of segmentation) Deutsch 1980 rhtym alines with pich, people do better than non-hierarchy Oura 1991 – MODEL OF HOW MANY PITCHES PEOPLE REMEMBER, use for corpus question on pattern matching

Hofsetter 1981 – people do better in bottom 4 time than 8 (again maybe confounded by IC)

Page 98 in Karpinksi has lenght and number of playings,

Effect of tempo in Unks, Bowers, and Eagle 1993

figure 3.1 is Karpinski method to understand dictation process

++++++++++++++++ Define the rationale and significance for this study talk about what the processes are that go into this What are the implicit transfer claims of this? + discussed in chapter 2 (history and rationale, Karpinski) + transfer literature also dicussed in chapter 2 Is there literature specifically on this? Yes, but scant.

what contributes to this whole process?

Note that there are two fields, both of which's literature can help out.

========== 63 words at start

Chapter 3

History of Aural Skills

3.1 First Establish Others think this is Important

3.1.1 Historical Evidence

3.1.2 Current Evidence

3.2 Solimization

3.2.1 What is Solimization

3.2.2 Brief History of it

3.3 Current State of Aural Skills

- Guy that just wrote that dissertation on it in England

History of Aural Skills a lot from other sources + Karpinski (Schumann, Smith, Benward and Car, Benward and Kolosick, Butler 1997) + Wolf and Colleagues + Best– thinking 'in' music 1992 + Serafine 1988 thinking in or with sound / + Elliott 1996 thinking about music without 'understanding' === These all really just have to do with mental representation?

Karpinski – "Music listeners who understaqnd what htey hear are thinking in music" <– claim page 4 + could imagine a thought experiment where understanding implicit and explicit knowledge of this

Karpinski notes that (Butler and Lochstampfor, 1993) no link between pedagogy and music cognition.

3.4 Old Farts To Talk About

- Guido of Arezzo
- Gioseffo Zarlino
- Franchinus Gaffurius
- C.P.E. Bach

- Jean-Philippe Rameou
- Arnold Schoenberg
- Heinrich Schenker
- Adriano Banchieri <– first to fix guido's hexachord
- Hubert Walerant (via Calvisius)
- Timothy Johnson's Article on solimization
- Gregory Barnett - cambridge guide, 17th Century Organization
- Lorenzo Penna
- Compare and contrast goals in terms of pedagogy and teaching.

3.5 Current State

- Books and what not.

Chapter 4

Individual Differences

4.1 Cognitive Aparatus

4.2 Training Effects

4.3 Transfere Literature

4.4 Memory for Melodies Literature

4.5 WMC

- Nichols, Wollner Halpern, 2018

4.6 Gf

4.7 Outline Notes

- Melodic Dictation is clearly something that uses WM
- Also dependent on WMC
- Problem is that there is not a direct comparison
- WMC tasks, simple and complex are with novel stimuli
- Even in cases of WMC, need to control for word frequency
- This allows us to know that exposure effects this ability
- Huge amount of work on statistical exposure (Saffran, Huron, Margulis, Pearce)
- Could take theories of WMC but capacitity limits and WMC task do not medoel the sequential and hierarchical nature of melodies
- Obvious alternative to this is to look at n-grams in melodies
- Image chart where overlay of n-gram is reflected in frequency distribution of chart

- Clealry we have task where complex entertaining of information and working
- What is emlodic equivlient to the word length effect?
- Is there such a thing with decay and melodies (Lewandasky + Corey's work)
- Hard to model idea of repeating things bc of rhythm problem and temporal properties
- STOP IT WIHT THE MILLER (Articles that reference Miller but get it wrong list)
- Question of how is music represented, is there some sort of pholoogical representation (is then the point to split the intervals with each phonological rep with the episodic buffer playing a role?)
- Do students need to know what their WMC maximum is

4.8 Cowan Reading Notes

- It's helpful to assume there are constants in psychology
- Why prefer Cowan over Baddeley, boat example
- Stop with the miller 7 quotes, should be listing of these
- WMC as form of attention
- History of WMC models (Process Model Attkinson, Baddely, Berz, Cowan)
- Rapid formation of new episodic buffer
- Is solfege assigment automatic? Transferred to new realm of representation
- Need to get away from idea of chunking for MMD
- Melodies are always in serial order
- Aka from above need to look at n-gram representation
- could imagine making some sort of sensory memory experiemnt ala page 114
- More options to write down, more error on recall, clearly not free recall situation, pattern matching
- I want examples of frequency distribution confounding memory experiemnts

4.9 Baker Model of Melodic Dictation (Over Karpinski)

- Divert attention to maximum n-gram
  - Open n-gram/attn to LTM matching
  - When LTM match maxed, put n-gram in phological loop
  - Transcribe all matched n-gram with LTM match ups (effecient processing? sd)
  - {Warning if beyond capacity limit} (tho how does this relate to LTM)
  - IF {Chunk is understandable => Transcribe}
  - IF {Chunk is not understandable –> Segment to smaller unit }
    - LTM as first option (contextualized)
    - Rhythmic and Contour framework – SD options first on contour – Avoid Interval (last resort) requires LTM single interval pattern match with n-gram of loop – Also avoid interval because it disgards maximum of n-gram

  - Only patterns with LTM match will be transcribed (aka do sight singing)
  - If not LTM match, then need recursive process to figure out new schema for looped n-gram
- Also, model that took n-gram funcitonality into the description would also account for weird atonal melodies where they have no function, but rather are built upon diatonic sequencs that are linked together with atonal gestures
- Theoretical reasons for stopping atomistic sight singing
  - It's only small block of more fluid and complex process
  - Could AP mapping be brought in here?
- Span speed correlation and doing some sort of melody thing wiht an experiment
- Eventually do POT and Music for this

Chapter 5

Musical Parameters

5.1 Inspiration from Computational Linguistics

5.2 Feature Extraction in Music

5.2.1 Symbolic Approaches (Static)

5.2.2 Symbolic Appoaches (Dynamic)

5.2.3 Behavioral Results

5.3 Point is that these features can stand in for intuition

Chapter 6

Corpus

6.1 Why need new data

6.2 History of Corpus Studies

6.3 Current State in Music

6.4 Limitations

6.5 Boring Corpus Stuff

6.5.1 Encoding Process

6.5.2 Sampling Criteria

6.5.3 Situation of Corpus Methods

6.6 Descriptives of the Corpus compared to Essen/Dutch/Whatever

Chapter 7

Final Words

We have finished a nice book.

You can label chapter and section titles using `{#label}` after them, e.g., we can reference Chapter 2. If you do not manually label them, there will be automatic labels anyway, e.g., Chapter **??**.

Figures and tables with captions will be placed in `figure` and `table` environments, respectively.

```
par(mar = c(4, 4, .1, .1))
plot(pressure, type = 'b', pch = 19)
```

Reference a figure by its code chunk label with the `fig:` prefix, e.g., see Figure 7.1. Similarly, you can reference tables generated from `knitr::kable()`, e.g., see Table 7.1.

```
knitr::kable(
  head(iris, 20), caption = 'Here is a nice table!',
  booktabs = TRUE
)
```

You can write citations, too. For example, we are using the **bookdown** package (Xie, 2018) in this sample book, which was built on top of R Markdown and **knitr** (**?**).

7.1 Chapter Format

- Claims from Fellowship

7.2 Chapter 1

- Theoretical Background Rationale for Computational Musicology and cognitive psychology
  - One
  - Two
    - One a
    - Two b
- Goal in mind is how people learn melodies
- Factors thought to contribute to mmd
- End with polymorphism

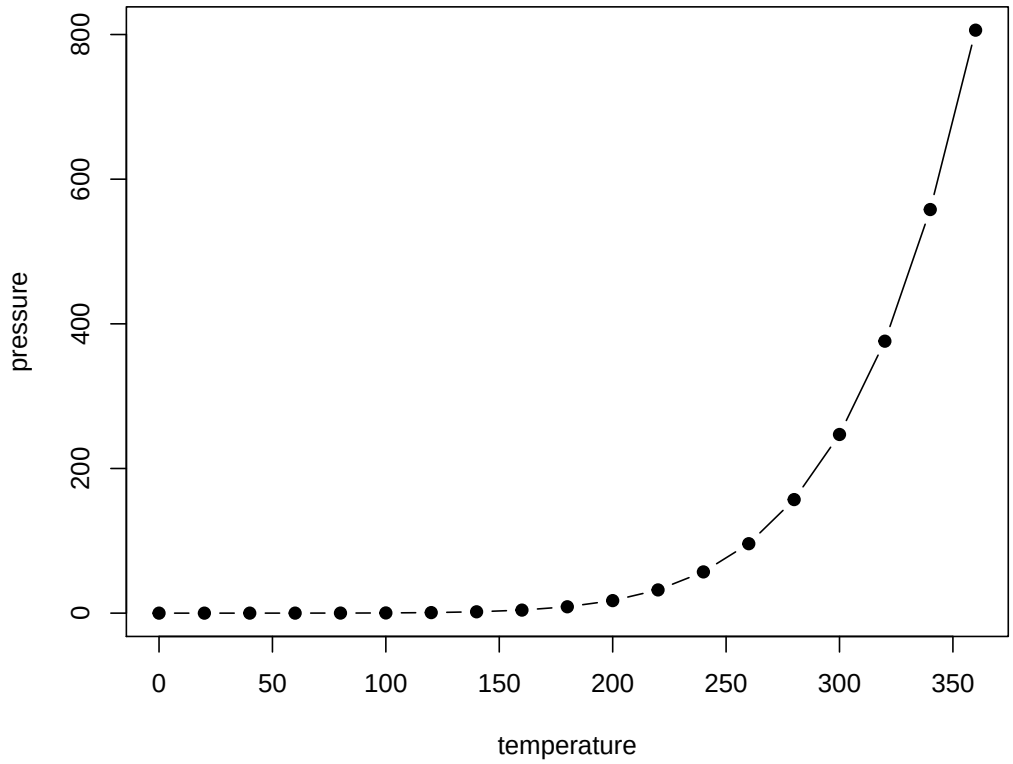

Figure 7.1: Here is a nice figure!

Table 7.1: Here is a nice table!

Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
5.1	3.5	1.4	0.2	setosa
4.9	3.0	1.4	0.2	setosa
4.7	3.2	1.3	0.2	setosa
4.6	3.1	1.5	0.2	setosa
5.0	3.6	1.4	0.2	setosa
5.4	3.9	1.7	0.4	setosa
4.6	3.4	1.4	0.3	setosa
5.0	3.4	1.5	0.2	setosa
4.4	2.9	1.4	0.2	setosa
4.9	3.1	1.5	0.1	setosa
5.4	3.7	1.5	0.2	setosa
4.8	3.4	1.6	0.2	setosa
4.8	3.0	1.4	0.1	setosa
4.3	3.0	1.1	0.1	setosa
5.8	4.0	1.2	0.2	setosa
5.7	4.4	1.5	0.4	setosa
5.4	3.9	1.3	0.4	setosa
5.1	3.5	1.4	0.3	setosa
5.7	3.8	1.7	0.3	setosa
5.1	3.8	1.5	0.3	setosa

7.3 Chapter 2

- History of Aural Skills
- Current State of Aural Skills
- Approaches and Goals

7.4 Chapter 3

- Cognitive Abilities
- WMC
  - Definition of Why WMC is related to this
  - Can learn a lot about melodic dictation by looking at WMC literature
- Experiment
  - Guts
- Discussion and Implications
  - Future studies need to look at WMC
  - Future verbal theoretical and computational models should involve capcity measures (limits)

7.5 Chapter 4

- Computation Chapter
- From computational linguistics and information theory comes music comp
- All papers citing FANTASTIC
- n-gram models and IDyOM

7.6 Chapter 5

- Hello, corpus
- History of Corpus studies (outside of music)
- Current state, limitations
- Descriptive statistics of the corpus

7.7 Chapter 6

- Experiments I and II
- Used mixed effects models to incorporate both individual and musical differences
- Problems with scoring (edit distance stuff, plus Buonviri)
- Computational model, how that informs thinking about it (reasons from Lewandowsky)

Chapter 8

Experiments

8.1 Rationale for Experiment

8.2 Selection of Melodies

- Tonalness, Countour, Number of Pitches - Long 1997 Tonalness good predictor
- Tonalness better than atonal (Frances 1958) Zenatti 1969 – from Long 1997
- Taylor 1977 – IC predicts when contour and lenght constant
- Long 1997 – IC affects information

8.3 Experiment I and II

8.4 Experiment III?

8.5 Limitations

8.5.1 How to Score

8.5.2 Reasons for making everything open source

8.6 Summaries

8.6.1 Applications to Pedagoges

8.6.2 Conceptual Frameworks

8.7 Conclusions

8.7.1 What can we really expect of undergrads?

Chapter 9

Reference Log

9.1 To Incorporate

- (Margulis, 2005) – Margulis Model
- (Nichols et al., 2018) – Specialty jazz background helps in tasks, WMC
- (**?**) – Fix intext
- (Schumann and Klauser, 1860) – Quote about why people should do ear training
- (Smith, 1934) – Quote from K2001 about why people should do ear training
- (Long, 1977) – Musical Characteristics predict memory
- (Taylor and Pembrook, 1983) – Great citation that lots of things change memory, even structural!
- (Tallarico, 1974) – Long boring talk on STM, LTM
- (Oura, 1991) – Awful experimental design that says people use structual tones
- (Buonviri, 2014) – Call for experimental, suggestions as to what factors might contribute, use of deductive reasoning, qualitative
- (Buonviri, 2015b) – People need to focus right away, not establish, distractors
- (Buonviri, 2015a) – Showing people visual music does not help much.
- (Buonviri, 2017) – Listening helps with other things, no best strategy in terms of writing
- (Buonviri and Paney, 2015) – Literature to say people are bad at teaching melodic dictation and we don't know a lot about it, also interesting stuff about what solfege systems people use
- (Butler, 1997) – Call for music educators to do aural skills research, notes problem with aural skills pedagogy in lack of direction, also nice Nicholas Cook quotes on point of theory
- (Furby, 2016) – music ed study with weird stats, has references to follow up on with advantages of pitch systems and people who reccomend things for sight singing
- (Pembrook, 1986) – Effects of melodies, also how people do it. Interesting that they too effect of melodies, but talka bout things in terms of notes and not in terms of information content. Thought ot have an experiment where the n-grams that are more common are easier to write down. Lots of good charts too.
- (Paney, 2016) – It's not good if you tell people what to do when they are dictating, article has a lot of good review for dictation materials to add to the 'toRead' folder.

- (Fournier et al., 2017) – Good references that people are awful at Aural Skills, Also suggestions that people are not that great at transfer, and some stuff to suggest academic abililty is intertwined in all of this. Good reference for when starting to talk about untangling the mess that is aural skills.
- (**?**, 1995) – Add on a new module to the WMC model of baddel with music, presents some evidence for why this theoretically should be included, but actually takes examples of dictation. A lot of this article felt like things that i was reinventing…not good.
- (**?**) – Proof some other people are starting to think in terms of pedagogical schemas
-

9.2 Chapter 3

- (Cowan, 2005) – This book will probably serve as cornerstone of chapter in terms of creating relevant literature in addition to EE course readings on WMC. Provides history of WMC models and notes how attention based model as opposed to Baddely loop might actually be better theoretical model for talking about fact that WMC could just be something related to attention if not that. Provides extensive listing on problems with chunking that are all relevant to music, but then also supports it. Shows that Miller 1956 is a generally bad citation, own author even says that in Miller 1989 (check and add) and says limit is probably about 4 (use Cowan 2001 for ctation find that). Lots of good ideas like how music is always serial recall, examples of how to model the process, great discussions on zooming out and categorical nature of music within span of WMC ideas.
- (Ockelford, 2007) – uses case of savant to argue bits of Berz WM Music Model

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