

Discrimination Between Phonograph Playback Systems

Jason A. Hockman,¹ David M. Weigl,² Catherine Guastavino,² and Ichiro Fujinaga¹

1. Distributed Digital Music Archives and Libraries (DDMAL) Laboratory, 2. Multimodal Interaction Laboratory (MIL)

Centre for Interdisciplinary Research in Music Media and Technology (CIRMMT), McGill University, Montréal, Québec, Canada

INTRODUCTION

- Phonograph records deteriorate during storage and playback; digitization is essential for preservation of cultural history
- What phonography playback equipment is necessary for optimal digitization?
- We report on results of 2 listening tests in which listeners attempt to discriminate between phonograph playback systems (PPS) in different price ranges
- Results intended to provide a set of guidelines for purchase of PPS components
- Digitization requires selection of PPS components:

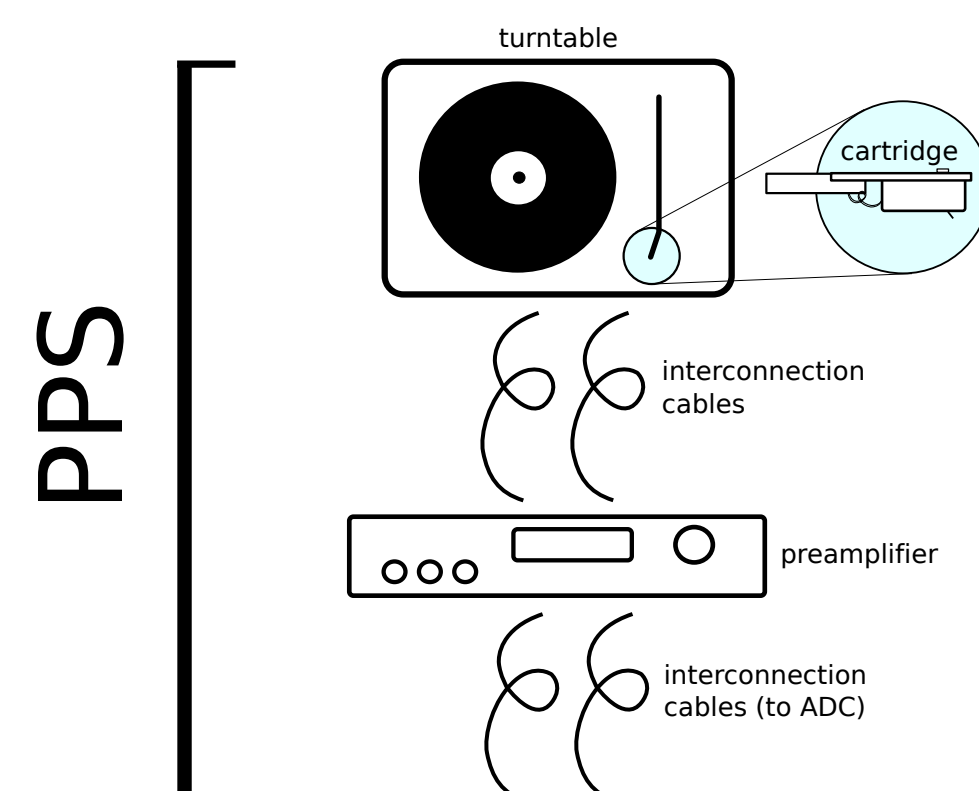


Figure 1: Phonograph Playback System (PPS) components

- Large number of products available in each component category
- Relatively little empirical tests to guide purchasing decisions
- Can expert listeners discriminate between closely matched PPS components from different price ranges?
- Double-blind AB preference test; significant preference implies discrimination

LISTENING TESTS

Participants

- Expert listeners: Professional sound engineers and sound recording students, all self-identified as audiophiles
- Condition 1: 11 participants, 9 males, mean age = 34.45, SD = 8.95
- Condition 2: 14 participants, 10 males, mean age = 33.07, SD = 8.27
- 9 of 11 participants in Condition 1 reported musical experience/training (mean = 13 years, SD = 6.892). 12 of 14 participants in Condition 2 reported musical experience/training (mean = 9.833, SD = 6.699)
- 8 participants from Condition 1 participated in Condition 2
- Participants were paid \$20 CAD for participation

System configuration and calibration

- The brands and models of the PPS components used in the study withheld
- Condition 1 tested participant discrimination of 2 distinct PPS (Figure 2a)
- Condition 2 tested participant discrimination of 2 PPS matched on all components except preamplifier (Figure 2b)

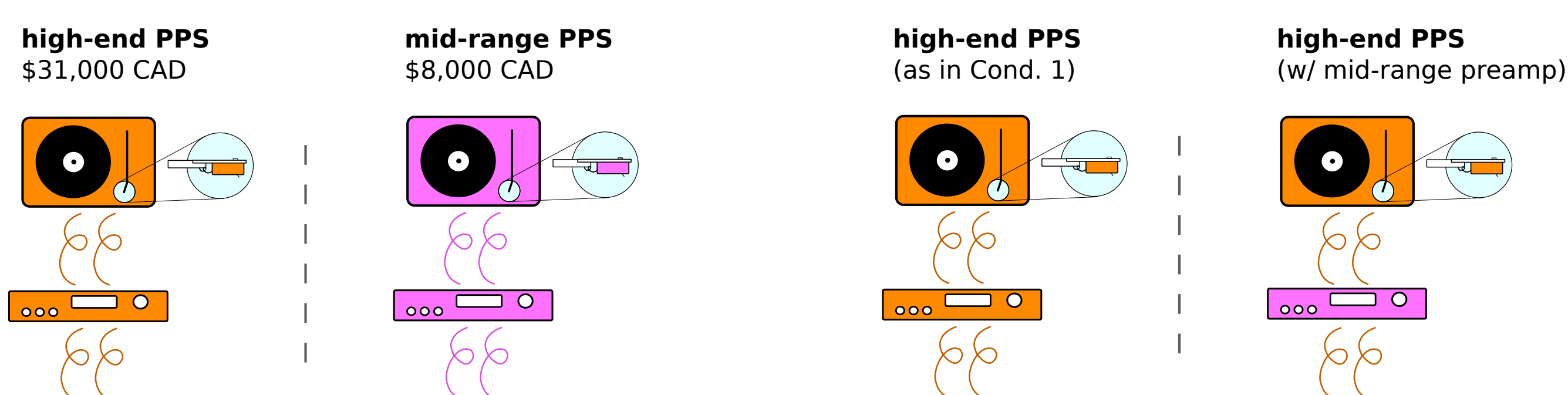


Figure 2a: PPS tested in Condition 1

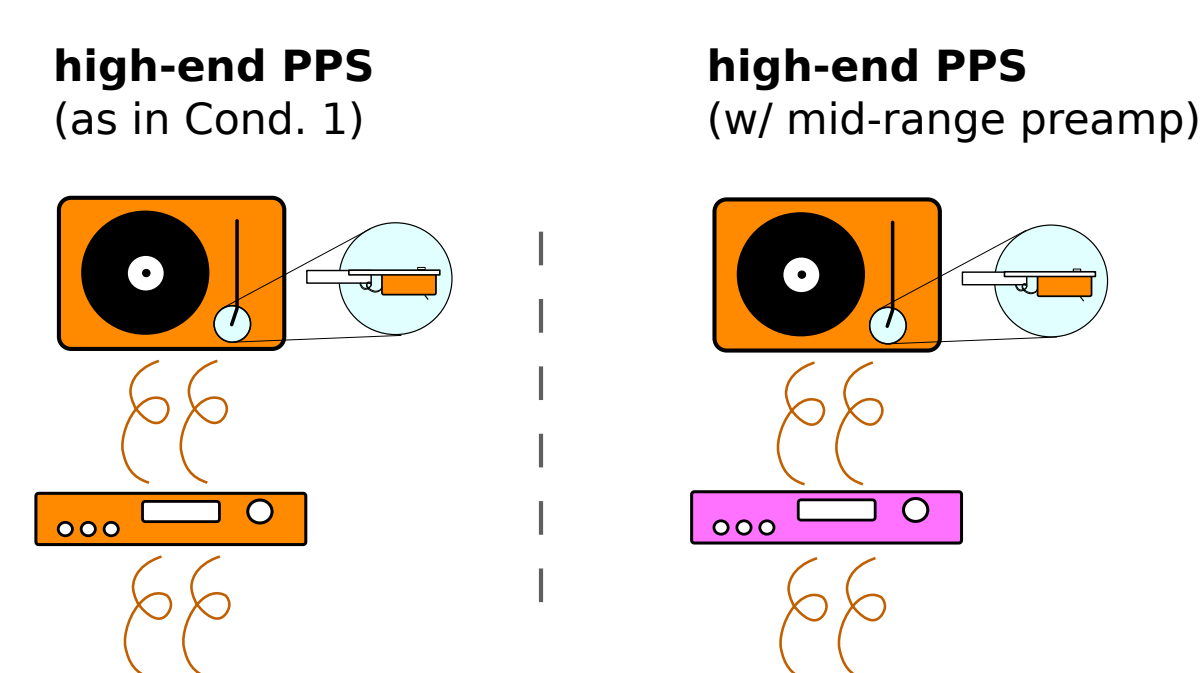


Figure 2b: PPS tested in Condition 2

- High-end system comprised of most expensive components in collection for each component class, with component compatibility verified by manufacturers or technicians

- Mid-range system (Condition 1) designed to be perceptually similar to the high-end system. Initial components selected for moderate price in collection. Perceived disparity was minimized by iterative refinement:

- replacing mid-range component n
- adjust setting for n within recommended range of acceptable settings
- equipment setup and calibration
- informal AB testing using MAX/MSP test patch (Figure 4)

Musical excerpts and digitization process

- Excerpts (Table 1) chosen based on reputation in the audiophile community

Artist	Album	Track	Label / Cat. no.	Genre	Length (m:s)
Gustav Holst	The Planets	Saturn, The Bringer of Old Age	Decca / SWL 6529	Classical	0:07
Miles Davis	Kind of Blue	Blue in Green	Columbia / CS 8163	Jazz	0:05
Pink Floyd	The Dark Side of the Moon	The Great Gig in the Sky	EMI / SHVL 804	Rock	0:08
Santana	Abraxas	Oje Como Va	MFSL / MFSL 1-305	Latin / Fusion	0:04
Steely Dan	Aja	Aja	Cisco / CLP-1006	Rock / Fusion	0:06

Table 1: Details of the five musical excerpts used in both Conditions 1 and 2

- Phonographs recorded (24-bit/96kHz) twice on each PPS in counterbalanced order with PrismSound ADA-8XR ADC and Apple Logic 7
- Gain of the mid-range system adjusted for level matching; consistency tested using MAX/MSP interface (Figure 4)
- Presented in ITU-standard listening room (Figure 3), using MAX/MSP interface



Figure 3: ITU-standard listening room

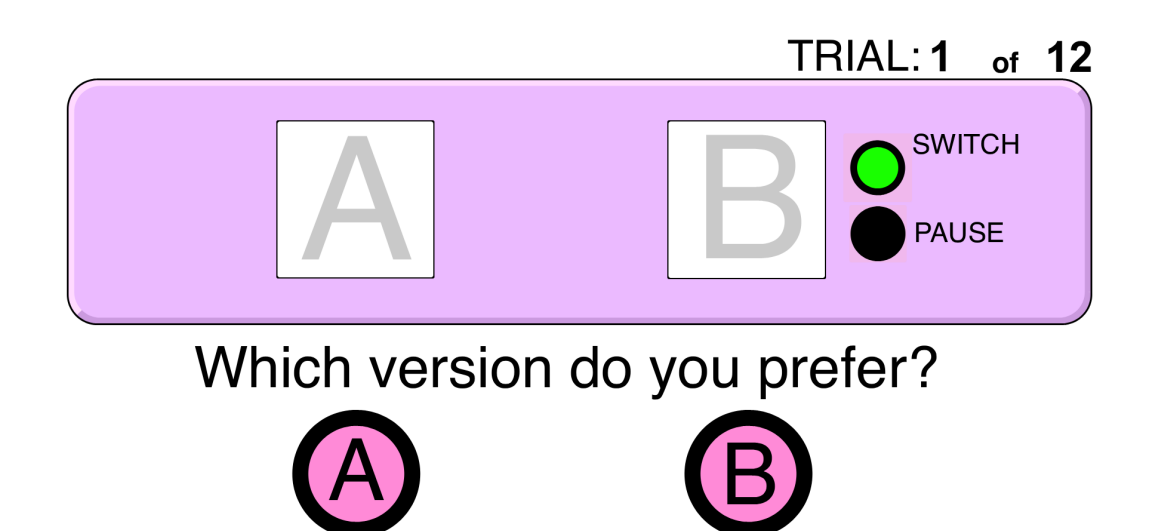


Figure 4: MAX/MSP patch used during experiments

Procedure

- 4 counterbalanced blocks (plus 1 training block), one excerpt per block. Full experiment took about 1 hour
- Each block contained 12 trials (randomized); in each trial, A and B associated with 2 of 4 versions of clip
- Participants required to listen to A and B once, then could replay each, switch between clips preserving playback location, pause/resume, or indicate preference
- Post-questionnaire including questions on demographics, familiarity, perceived difficulty and perceived differences

DISCRIMINATION BETWEEN PPS

- Friedman test performed to determine effect of excerpt on individual preferences: no significant effect, thus aggregating across excerpts was possible in analysis
- Šidák correction applied to adjust significance threshold for multiple comparisons

Overall discrimination

- Cumulative binomial analyses performed across participants in each condition
- Condition 1: participants significantly discriminated between PPS for Santana excerpt ($\beta_1 \approx 0.01$, $p < \beta_1$) but for no other excerpts. Aggregating across excerpts, significant preference for the high-end system was observed
- Condition 2: no significant discrimination between PPS for any excerpts. Aggregating across excerpts, only marginal preference ($p < 0.05$) for the high-end system was observed

Individual discrimination

- Cumulative binomial analyses performed for each participant and condition, to determine whether any individuals could significantly discriminate between PPS
- Condition 1: 2 of 11 participants significantly discriminated between systems ($\beta_2 \approx 0.0047$, $p < \beta_2$); 2 more participants reached marginal discrimination ($p < 0.05$)
- Condition 2: no participants discriminated significantly ($\beta_3 \approx 0.0037$); only 2 participants achieved marginal discrimination ($p < 0.05$)

CONCLUSIONS

- Our results indicate that discrimination between the 2 PPS is very difficult
- Limiting the inter-system variation to the preamplifier component makes the task even more difficult
- Possible future studies include further analyses of the effects of individual components not addressed in Condition 2, e.g., the cartridge, turntable, and interconnection cables

Work on this McGill Audio Quality Laboratory project was supported by a FQRSC team grant on the Perception of Audio Quality and the Canada Foundation for Innovation. The authors wish to thank Guillaume Boutard for the design of the graphical interface, the expert listeners who devoted their time to the study, and Yves Methot, Harold Killanski, and Julien Boissinot for their technical assistance during the experiments conducted at the Centre for the Interdisciplinary Research in Music Media and Technology (CIRMMT).