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# The use of auditory training to improve auditory processing in individuals with schizophrenia

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## Introduction

- Cognitive deficits are a core feature of schizophrenia.
- Most abnormal cognitive functions in schizophrenia are verbal learning and memory.
- Early auditory processing is also disturbed in schizophrenia.
- Impaired verbal memory and auditory processing (reduced mismatch negativity responses) are both associated with poor functional status.
- By improving the speed and accuracy of auditory processing through auditory training, higher-order cognitive functions such as verbal encoding and verbal memory retrieval have more reliable input to operate on.

## Question

Does auditory training improve auditory processing in individuals with schizophrenia?

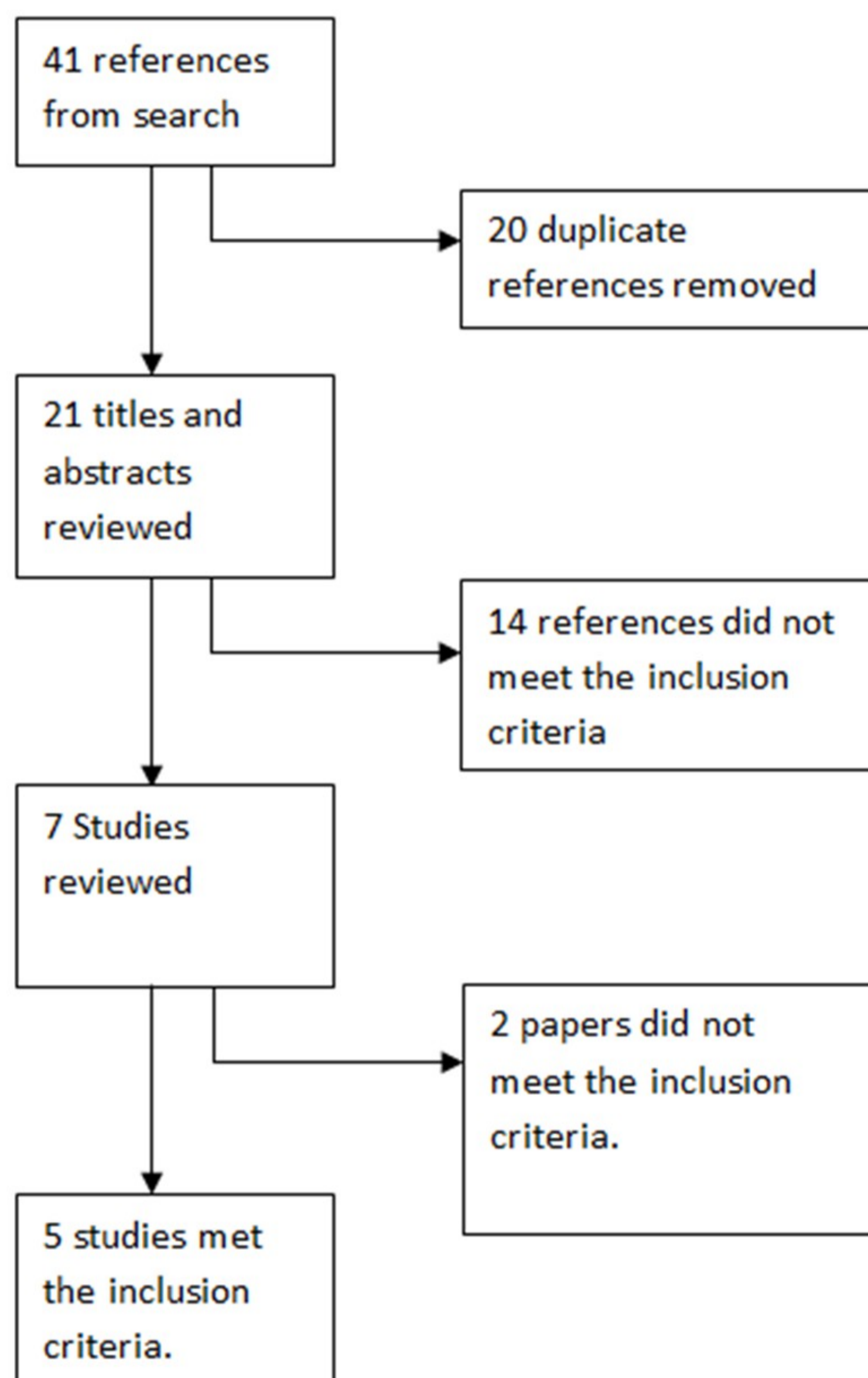
## Search Terms

	Keywords
Population	Individuals with schizophrenia Schizophrenia*
Intervention	auditory skills train* OR "auditory train*" OR "auditory intervention*" OR "auditory treatment*" OR "Fast ForWord" OR Earobics OR "auditory integration therap*" OR Tomatis OR LACE OR "phonemic train*" OR "Samonas" OR "Cognitive train*" OR "cognitive remediation**"
Outcome	auditory processing* OR "central auditory*" OR "CAPD" OR "APD" OR "central presbycusis" OR "aural learn*" OR "auditory discrim*" OR "auditory percept*" OR "listening comprehen*" OR "perceptual impair*" OR "auditory memory*" OR "auditory attention*" OR "auditory sustained attention**"

## Inclusion / Exclusion Criteria

Included	Excluded
1. Studies where the subjects were individuals with schizophrenia	1. All studies in languages other than English.
2. Studies where the intervention was auditory training	2. Studies evaluating potential biomarkers to identify the benefit of auditory training
3. Studies that included outcome measures of auditory processing	3. Studies where the intervention (auditory training) was combined with another intervention
	4. Studies where the outcome measure did not include measures of auditory processing

## Study Selection Process



## Results

Table 1. Characteristics of the studies included.

Reference	Design	n	Intervention	Outcome Measures		CCAT Quality Score
				Auditory processing measures	Cognitive measures	
Fisher et al. 2009	Randomized control trial	CC = 26; EC = 29	CC: computer games; EC: Auditory training (50 hours of computerized training over 10 weeks)	Behavioural - Auditory processing speed (time order judgment of pairs of frequency-modulated sweeps of auditory stimuli increasing or decreasing in frequency)	The Positive and Negative Syndrome Scale (PANSS), Quality of Life Scale—Abbreviated Version, measures recommended by the Measurement and Treatment Research to Improve Cognition in Schizophrenia (MATRICS)	70%
Fisher et al. 2014	Randomized controlled trial	CC = 43; EC = 43	CC: computer games; EC: Auditory Training (40 hours of computerized training over 8 weeks)	Behavioural - Auditory processing speed (time order judgment of pairs of frequency-modulated sweeps of auditory stimuli increasing or decreasing in frequency)	Global cognition, Speed of processing, Working memory, Verbal learning, Verbal memory, Visual learning, Visual memory, Problem solving, Positive and Negative syndrome scale total, Strauss Carpenter Outcome scale, Global functioning role scale, Global functioning social scale	75%
Murphy et al. 2012	Before/After with no control group	n = 55	Brain Fitness Program (40 1 hour sessions up to 5 times per week)	Behavioural - Auditory processing speed (time order judgment of pairs of frequency-modulated sweeps of auditory stimuli increasing or decreasing in frequency)	CogState® schizophrenia battery, a comprehensive computerized battery of cognitive measure; Digit Span task; two functional capacity outcome measures: UCSD Performance based Skills Assessment (UPSA-2) and Cognitive Assessment Interview (CAI)	63%
Popov et al. 2011	Randomized control trial	CC = 19; EC = 20; healthy controls = 15	EC: auditory-focused training program (1 hour sessions over 20 days) CC: broader cognitive training program (three 1-1.5 hour sessions per week for four weeks)	Electrophysiological - Auditory sensory (magnetoencephalographic (MEG) M50) gating recorded in a paired click design (ability of the brain to suppress the response to the second of two paired stimuli.).	German equivalent of the California Verbal Learning Test (Verbaler Lern- und Merkfähigkeitstest [VLMIT]) and a verbal fluency test (Regensburger Wortflüssigkeitstest [RWT])	80%
Popov et al. 2012	Randomized control trial	healthy controls = 15; CC = 18; EC = 18	EC: auditory-focused training (1 hour sessions over 20 days) CC: broader cognitive training program (three 1-1.5 hour sessions per week for four weeks)	Electrophysiological - Auditory sensory (magnetoencephalographic (MEG) M50) gating recorded in a paired click design (ability of the brain to suppress the response to the second of two paired stimuli.). Two oscillatory measures: gamma increase and alpha decrease.	California Verbal Learning Test, Global function	80%

Table 2. Results of the studies included (Y = Yes, N = No).

Reference	Significant improvement in auditory processing measures?	Significant improvement in cognitive measures?	Improvement in auditory processing associated with gains in cognitive measures?
Fisher et al. 2009	Y	Y (global cognition, verbal working memory, and verbal learning and memory)	Y
Fisher et al. 2014	Y	Y (global cognition, verbal memory, and problem solving)	Y
Murphy et al. 2012	Y	N	N
Popov et al. 2011	Y for auditory training; N for cognitive training	Y (immediate recall, working memory, delayed recall); more improvement for auditory training than cognitive training	Y
Popov et al. 2012	Y; auditory processing (M50 ratio) normalized after auditory training but not after cognitive training	Y (verbal memory, global functioning); more improvement for auditory training than cognitive training	Y

## Conclusions

- Auditory training improves auditory processing in individuals with schizophrenia.
- Auditory training improves cognition in individuals with schizophrenia.
- Improvement in auditory processing is associated with gains in cognition.

## Limitations and Future Directions

- Few studies met the selection criteria. Studies had small sample sizes, did not use objective measures of real-world functioning, did not explore dose-response relationships, had confounding variables such as medications, at-home exposure to computerized activities etc., did not study the long term impact of intervention, and had subjects that were provided monetary compensation.
- Future studies should control for confounding variables, have adequate sample sizes, look at long-term effects of auditory training, look at the underlying mechanism, and use a broader audiological and neuropsychological test battery.

## References

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