

On the characterization of binaural contributions to speech intelligibility in multitalker situations

Von der Fakultät für Medizin und Gesundheitswissenschaften
der Carl von Ossietzky Universität Oldenburg
zur Erlangung des Grades und Titels eines
Doktors der Naturwissenschaften (Dr. rer. nat.)
angenommene Dissertation

von Frau
Esther Schoenmaker
geboren am 30. März 1980
in Mijdrecht, Niederlande

Gutachter: Prof. Dr. Ir. Steven van de Par

Weitere Gutachter: Prof. Dr. Adelbert Bronkhorst

Prof. Dr. Volker Hohmann

Tag der Disputation: 17. Februar 2017

Berichte aus der Akustik

Esther Schoenmaker

**On the characterization of binaural contributions
to speech intelligibility in multitalker situations**

Shaker Verlag
Aachen 2017

Bibliographic information published by the Deutsche Nationalbibliothek

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at <http://dnb.d-nb.de>.

Zugl.: Oldenburg, Univ., Diss., 2017

Copyright Shaker Verlag 2017

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the publishers.

Printed in Germany.

ISBN 978-3-8440-5424-8

ISSN 1611-1303

Shaker Verlag GmbH • P.O. BOX 101818 • D-52018 Aachen

Phone: 0049/2407/9596-0 • Telefax: 0049/2407/9596-9

Internet: www.shaker.de • e-mail: info@shaker.de

Contents

Summary	1
Zusammenfassung	3
1 General Introduction	5
1.1 Binaural Cues and Mechanisms	6
1.2 Outline	10
2 The multiple contributions of interaural differences to improved speech intelligibility in multitalker scenarios	13
2.1 Introduction	14
2.2 Stimulus Processing	18
2.2.1 Control stimuli	18
2.2.2 Equal local azimuth processing	19
2.3 General Methods	25
2.3.1 Speech stimuli	25
2.3.2 Talker positions	26
2.3.3 Set-up	27
2.4 Experiment 1: Influence of Simultaneous Interaural Cue Disparities	27
2.4.1 Participants	27
2.4.2 Task	28
2.4.3 Spatial conditions	29
2.4.4 Method	29
2.4.5 Results	30
2.5 Experiment 2: Quality Test	32
2.5.1 Participants	32
2.5.2 Method	33
2.5.3 Results	33
2.6 Model Predictions	34
2.6.1 BSIM	35
2.6.2 Method	36
2.6.3 Results and discussion	37
2.7 Discussion	39
2.7.1 Spatial release from masking due to simultaneous ICDs	40

2.7.2	Spatial release from masking caused by stimulus properties other than simultaneous ICDs	40
2.7.3	Target enhancement vs interferer suppression	42
2.7.4	Binaural improvement in relation to stimulus properties	43
2.8	Conclusion	44
3	Intelligibility for binaural speech with discarded low-SNR speech components	45
3.1	Introduction	46
3.2	Methods	47
3.2.1	Stimuli	47
3.2.2	Target Signal Manipulation	48
3.2.3	Procedure	50
3.3	Results	51
3.4	Discussion	52
4	Salient spatial cues help to assign stimulus components to the target speech	55
4.1	Introduction	56
4.2	Material and methods	56
4.2.1	Principle of stimulus manipulation	57
4.2.2	Implementation of stimulus manipulation	57
4.2.3	Material and methods shared with previous stimuli	60
4.3	Results	61
4.4	Discussion	63
5	Better-ear rating based on glimpsing	67
5.1	Introduction	68
5.1.1	Factors contributing to the spatial benefit	68
5.1.2	Better-ear rating	69
5.2	General Methods	71
5.2.1	Speech material	72
5.2.2	Task	72
5.2.3	Stimulus presentation	74
5.2.4	Spatial processing	74
5.3	Experiment 1	77
5.3.1	Participants	77
5.3.2	Spatial configurations	77
5.3.3	Procedure	78

5.3.4	Results	78
5.4	Better-ear rating	80
5.4.1	Metrics to express better-ear rating	80
5.4.2	Analysis of better-ear advantage provided by the stimuli	82
5.4.3	Better-ear rating as a predictor for the performance in experiment 1 .	86
5.5	Experiment 2	89
5.5.1	Participants	90
5.5.2	Spatial configurations	90
5.5.3	Better-ear ratings	90
5.5.4	Procedure	91
5.5.5	Results	92
5.5.6	Discussion	96
5.6	General discussion	97
5.6.1	The concept of better-ear rating	97
5.6.2	Stimulus types and their contribution to spatial benefit	98
6	General discussion	101
6.1	Main findings of this thesis	101
6.1.1	Binaural unmasking	101
6.1.2	Segregation supported by spatial cues present in glimpses	102
6.1.3	Better-ear listening based on glimpses	103
6.1.4	Conclusion	104
6.2	Further implications of this work	104
6.2.1	Glimpses as the main carrier of information	104
6.2.2	Binaural unmasking	106
6.2.3	Spatial filtering in human listeners	107
6.2.4	Equalization-cancellation theory as a spatial filter	109
Appendix		111
Bibliography		115
Acknowledgments		127
Curriculum Vitae		129