

**TEXT BOUND
INTO
THE SPINE**

**CONTAINS
PULLOUTS**

THE FUNCTIONAL ANALYSIS OF SHOE WEAR PATTERNS: THEORY AND APPLICATION

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VOL. 2

VOLUME TWO

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DIAGRAMS

DIAGRAM 1 Comparison of past published wear pattern sketches


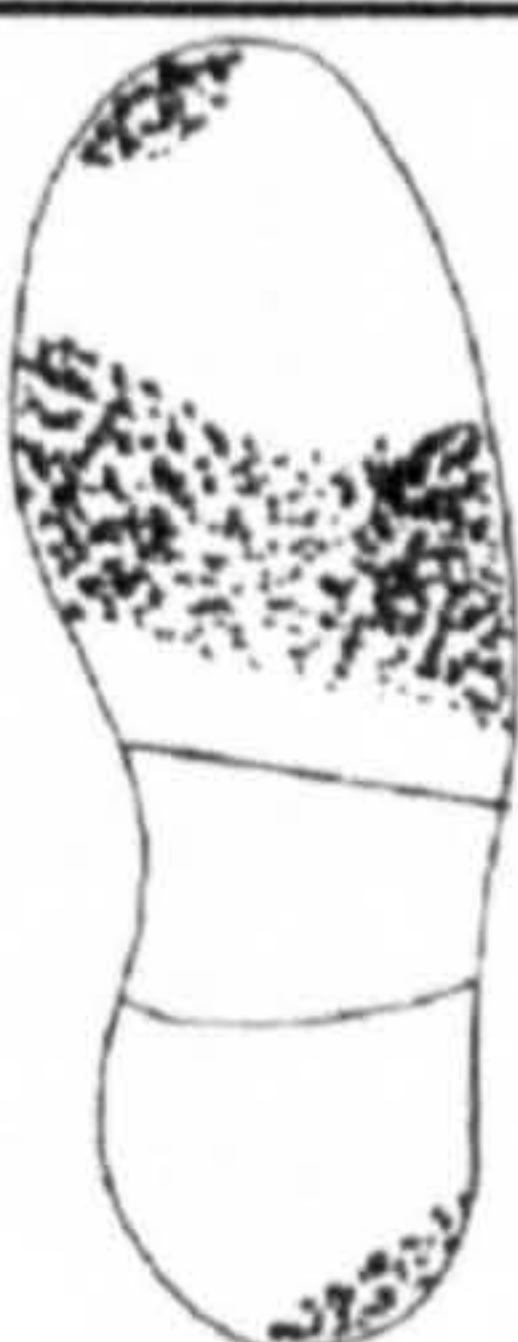
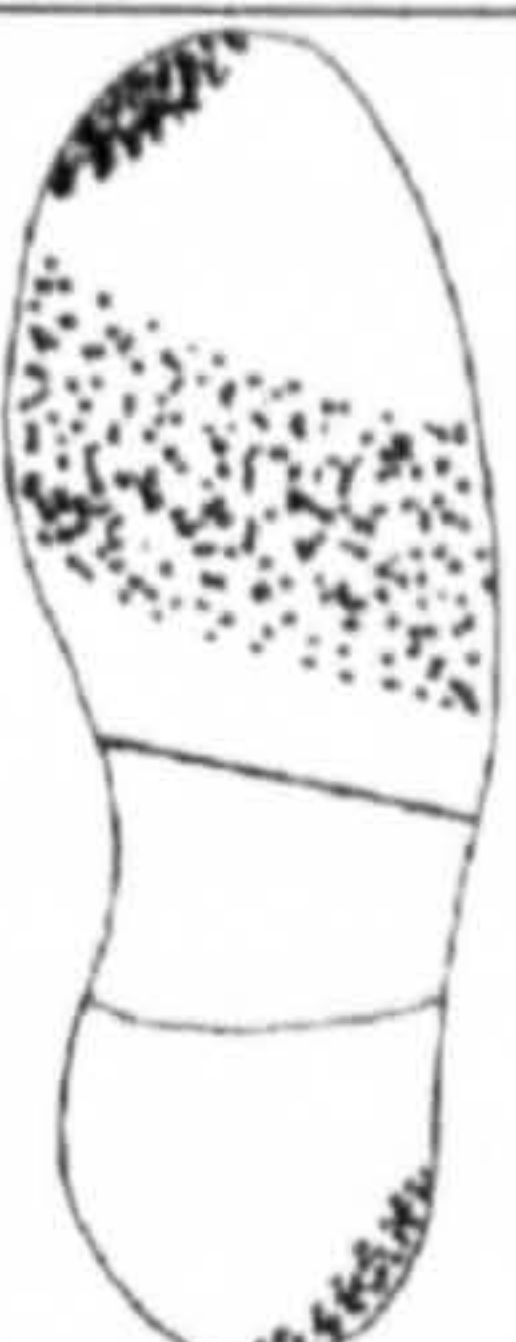











	Outsole wear patterns depicted for foot pathologies by author				
Foot pathology	Gibbard	Hanby and Walker	Turchin	Napier	Lucock
Normal foot					
Hallux rigidus					
Hallux valgus					
Overloaded metatarsals					
Pes cavus					

DIAGRAM 2 Sequence of progression of the research

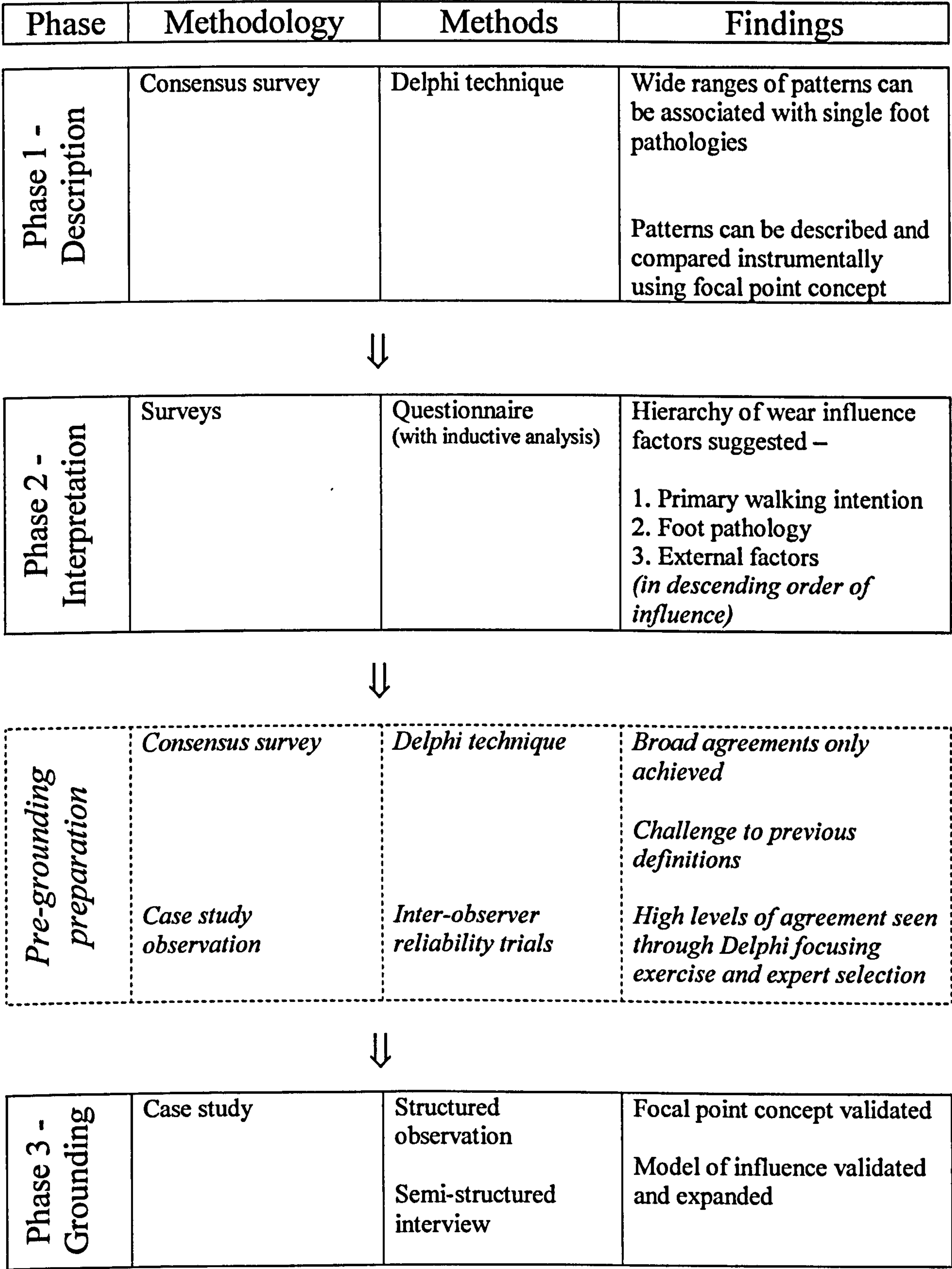


DIAGRAM 3 Instrument for the description and comparison of shoe wear patterns

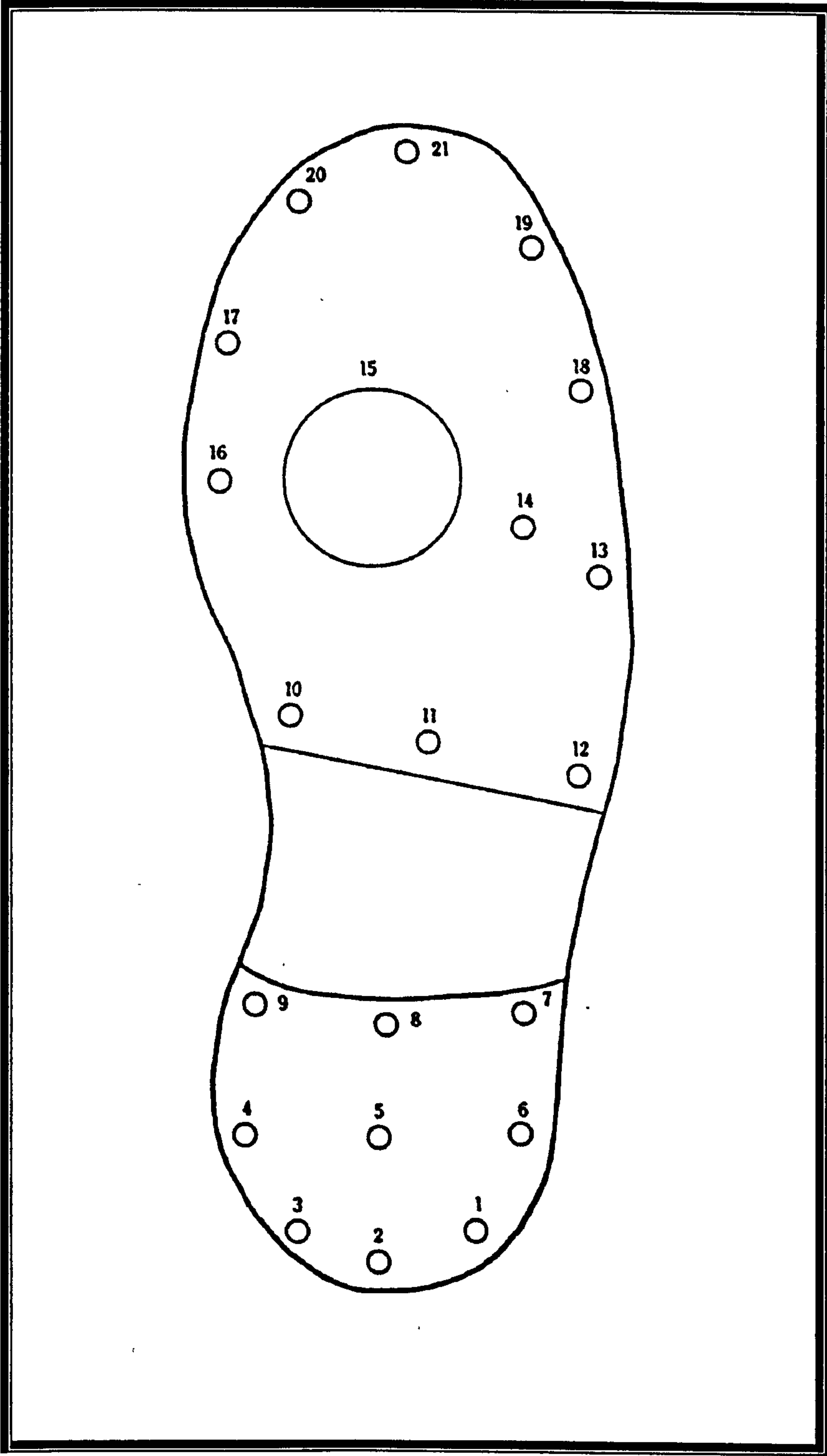


DIAGRAM 4 Blank outsole outlines which participants provided wear pattern depictions on

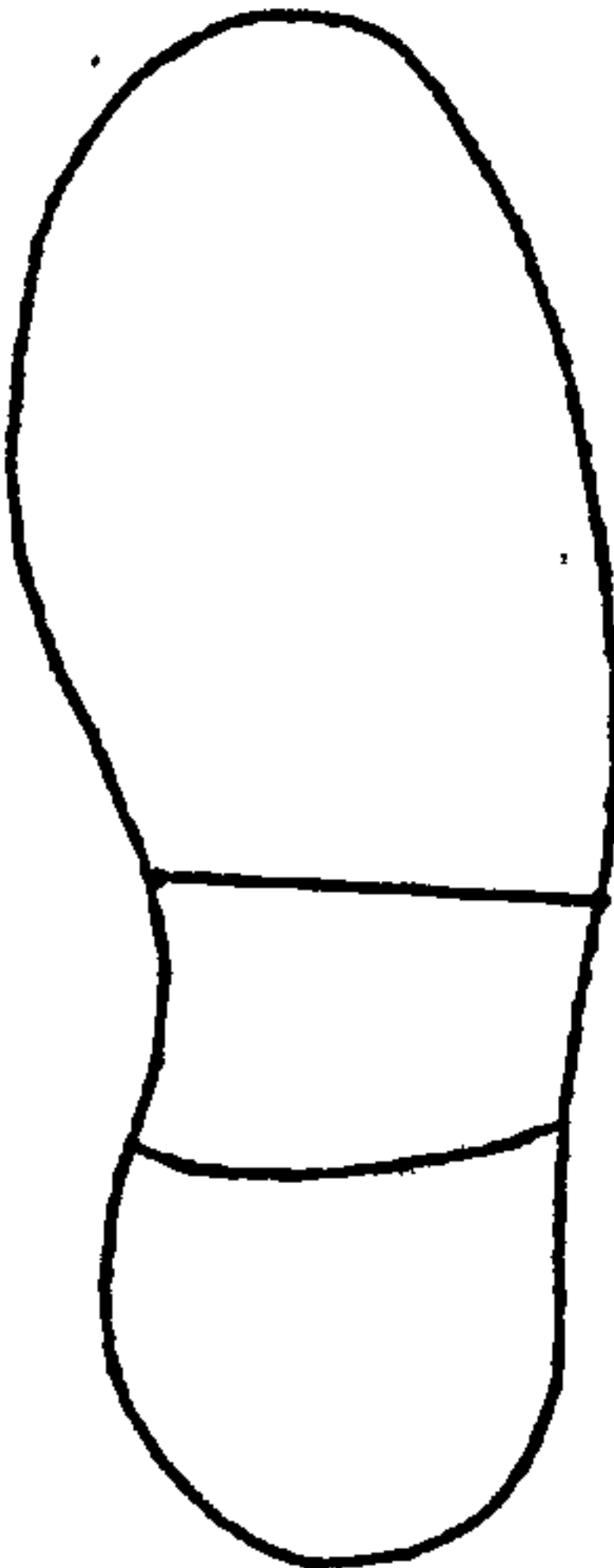
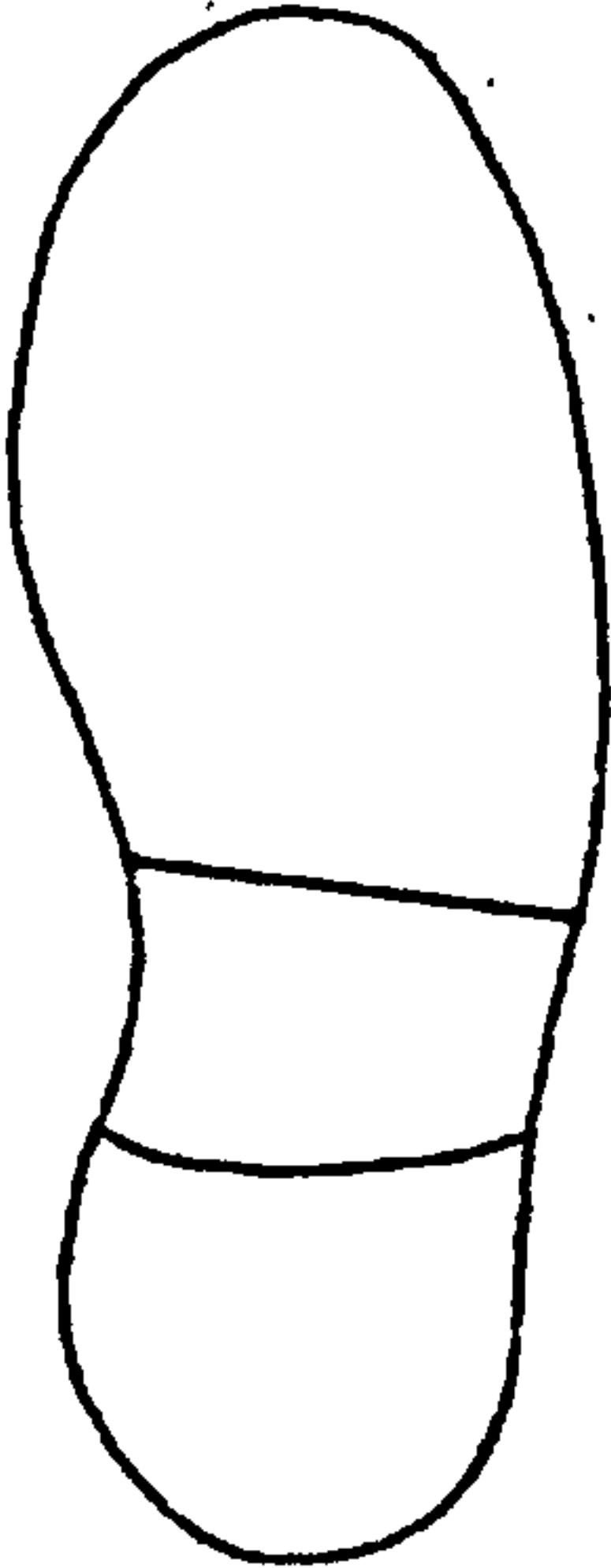
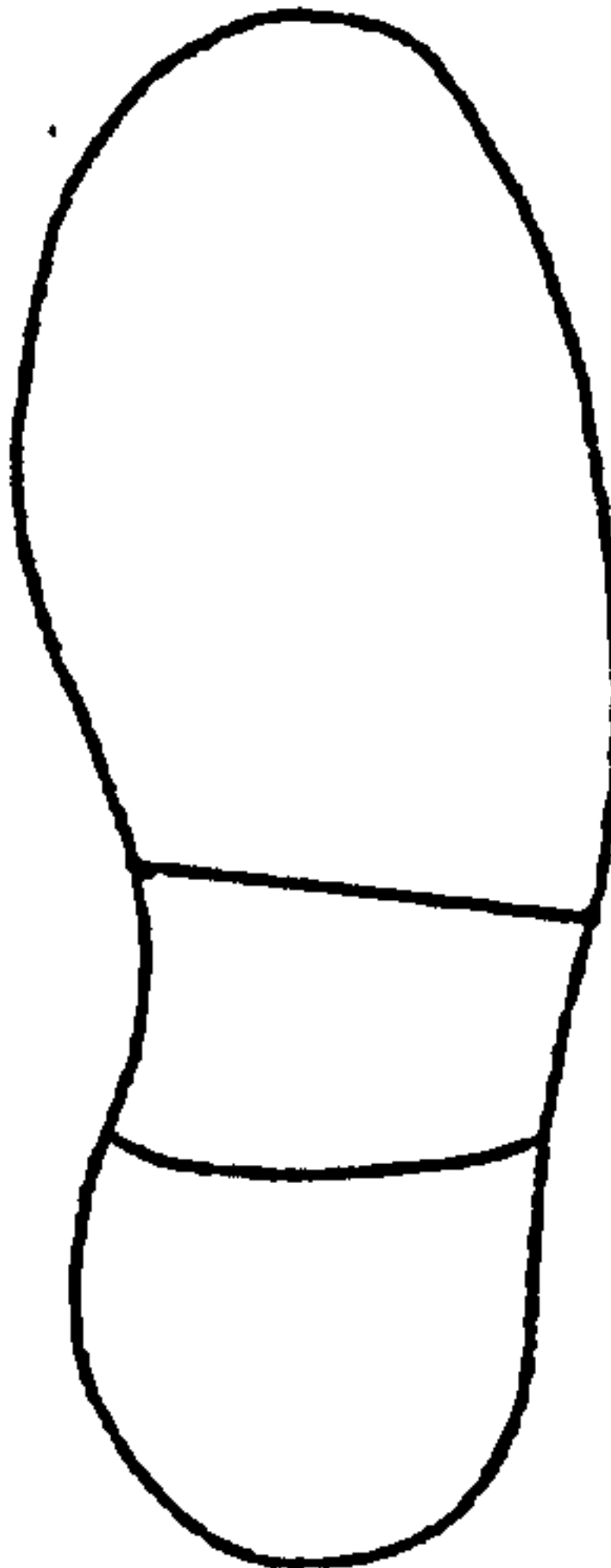
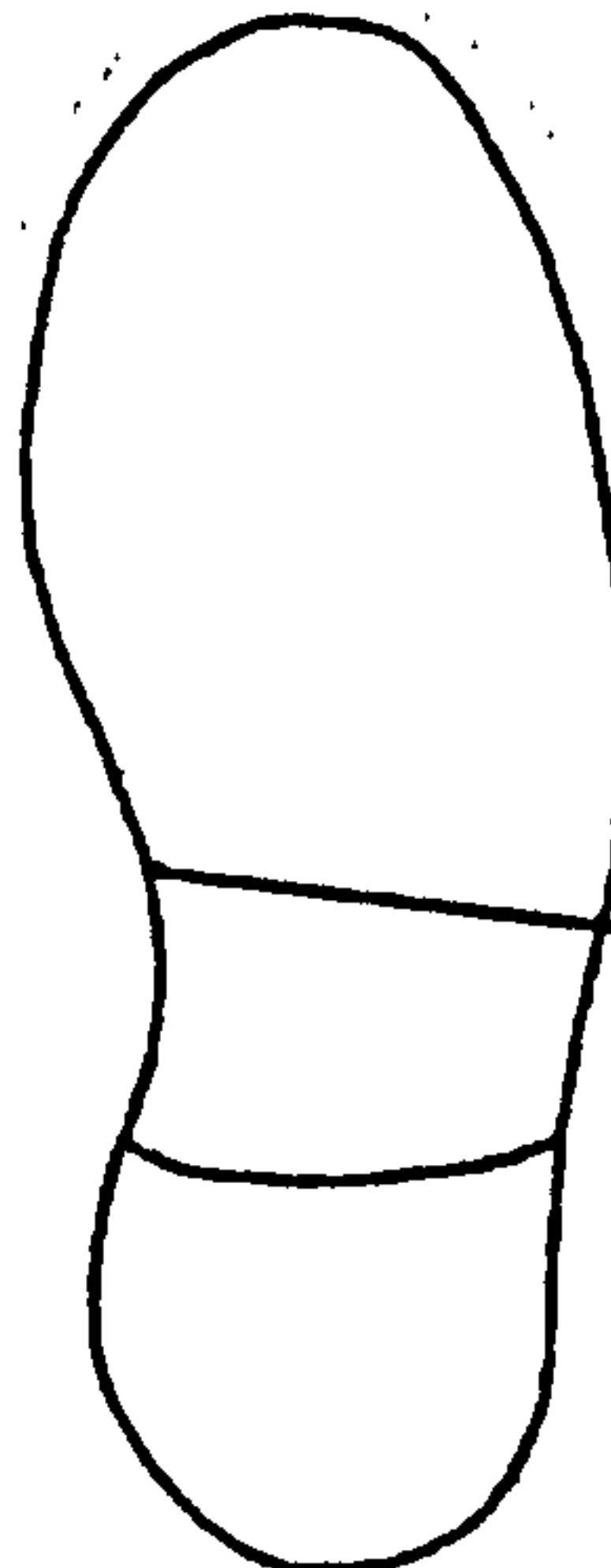
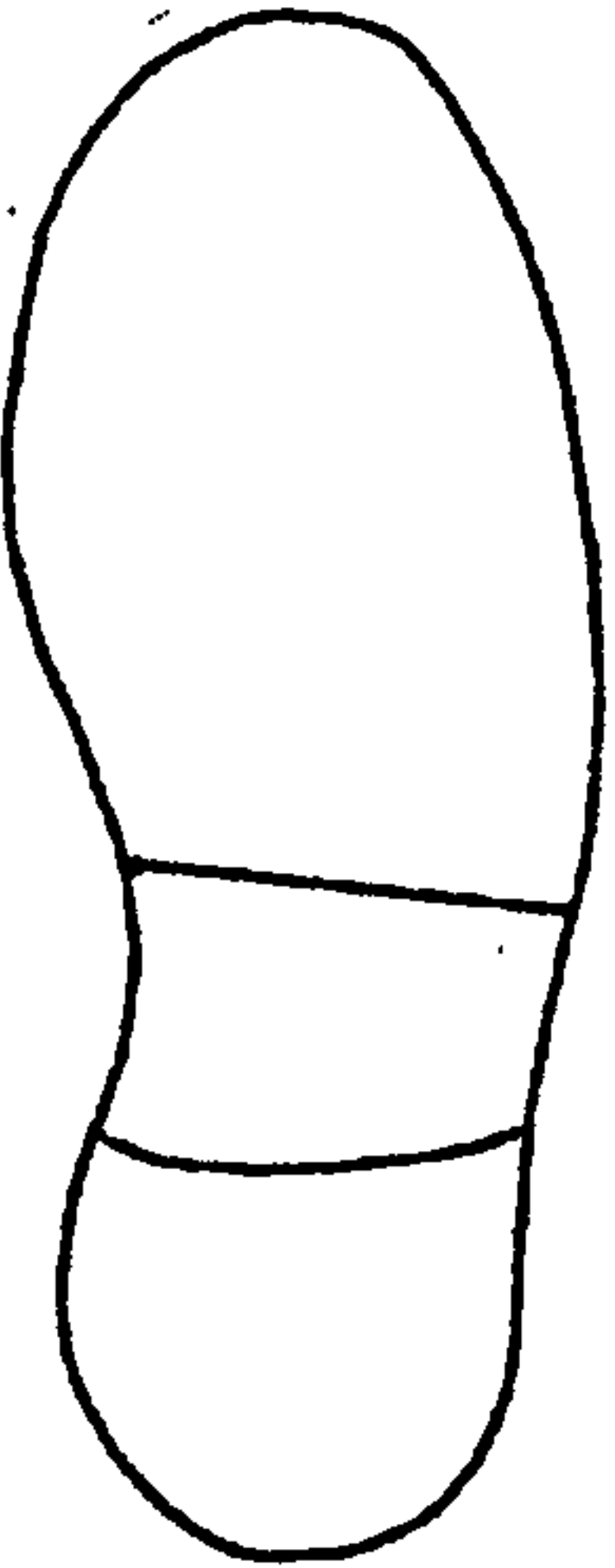
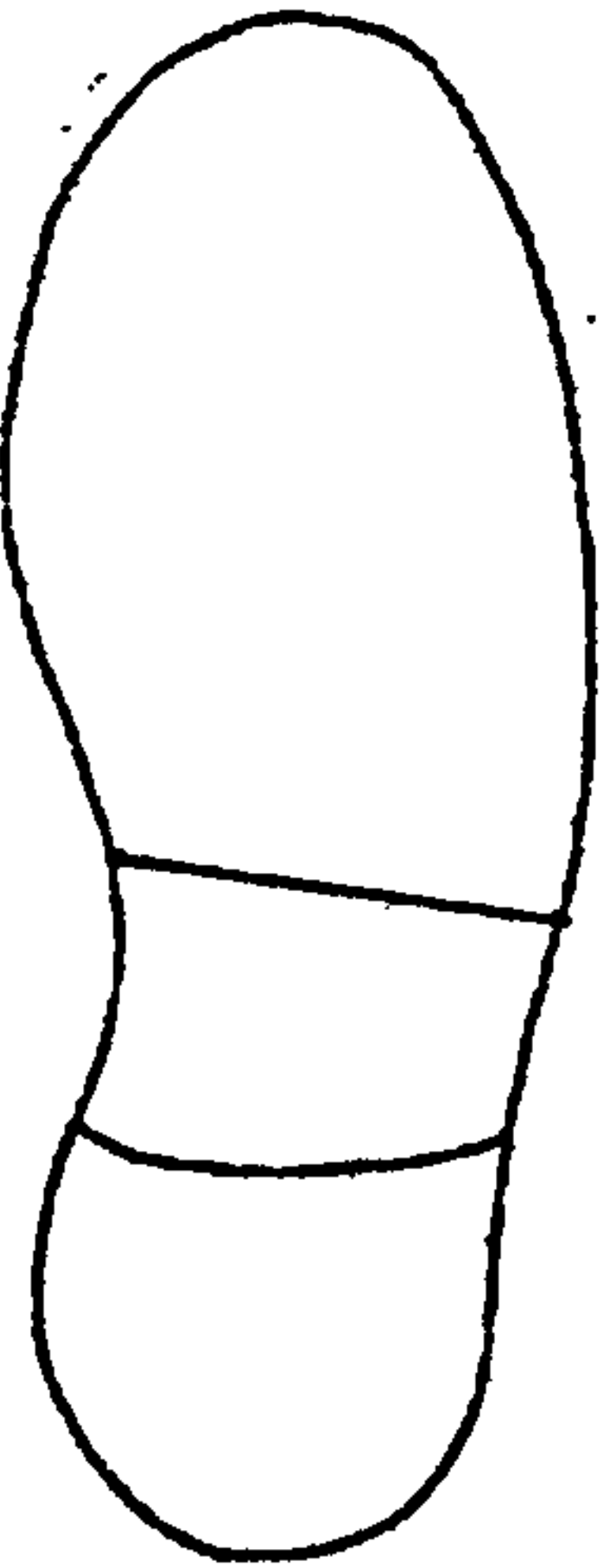
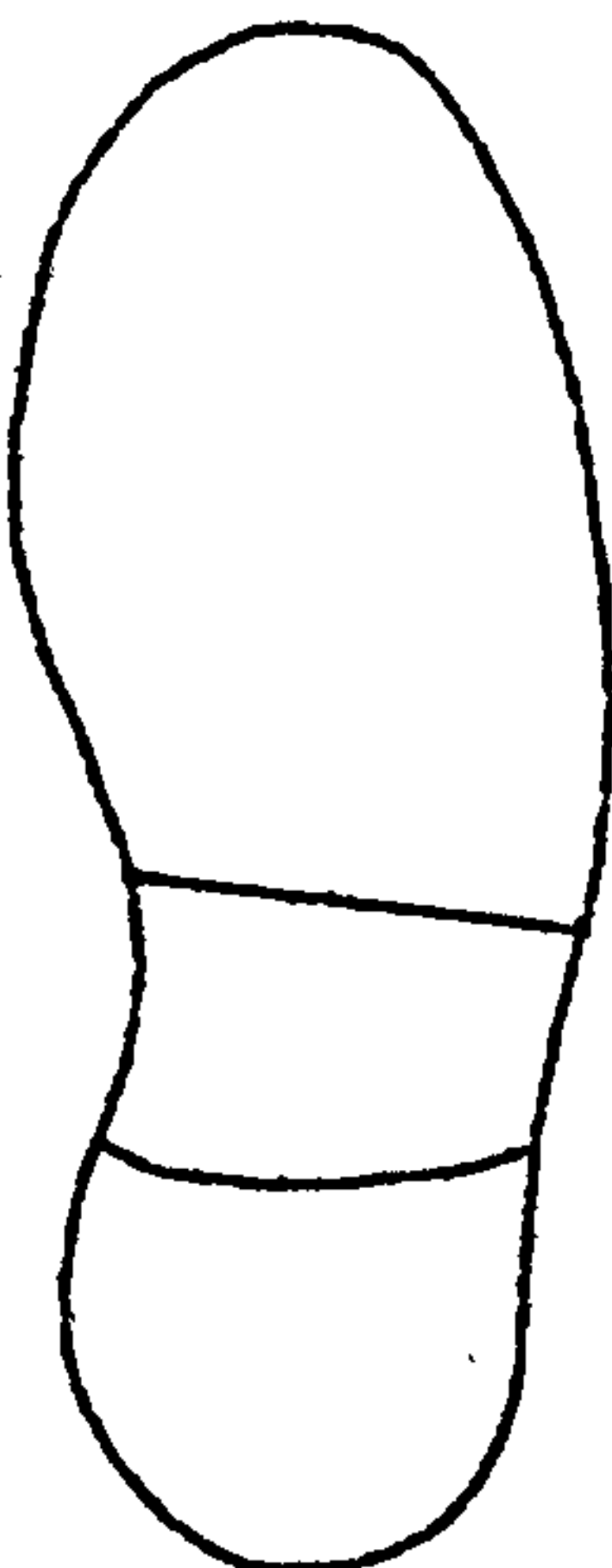
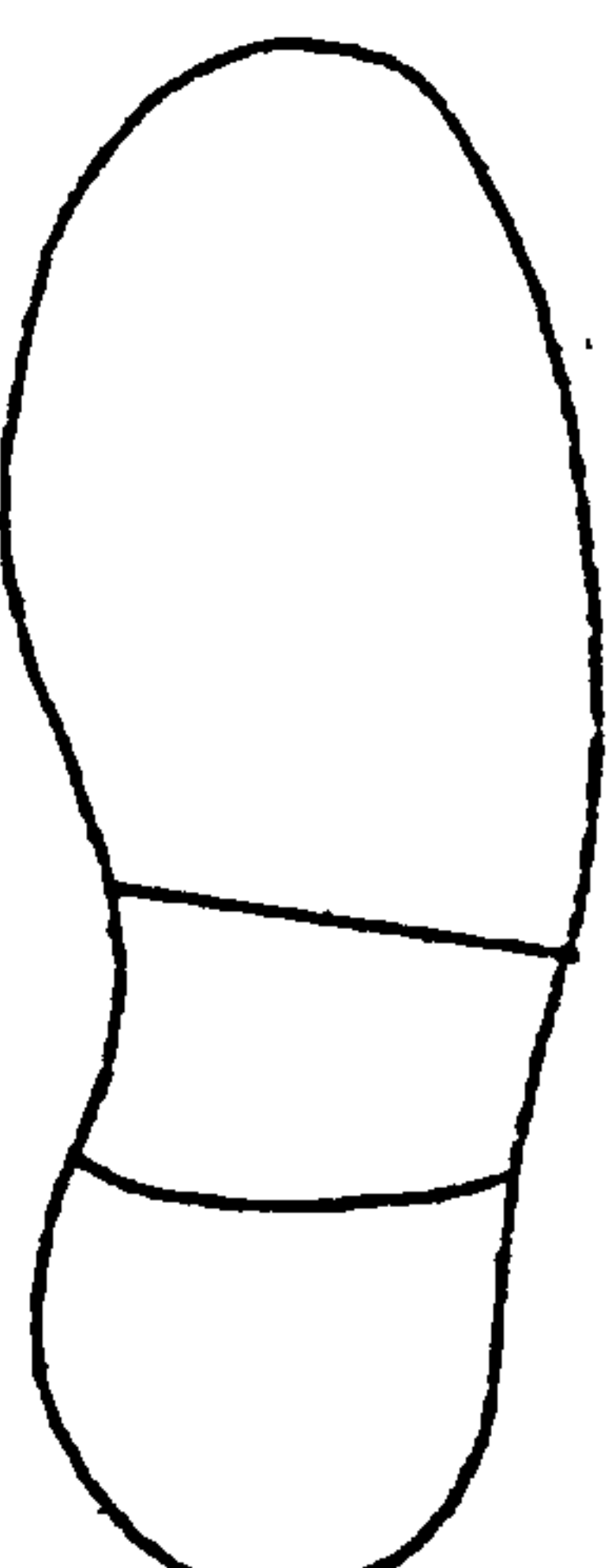
Associated State -----	Associated State -----	Associated State -----	Associated State -----
			
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DIAGRAM 5 Example of common wear areas presented by respondents for hallux rigidus

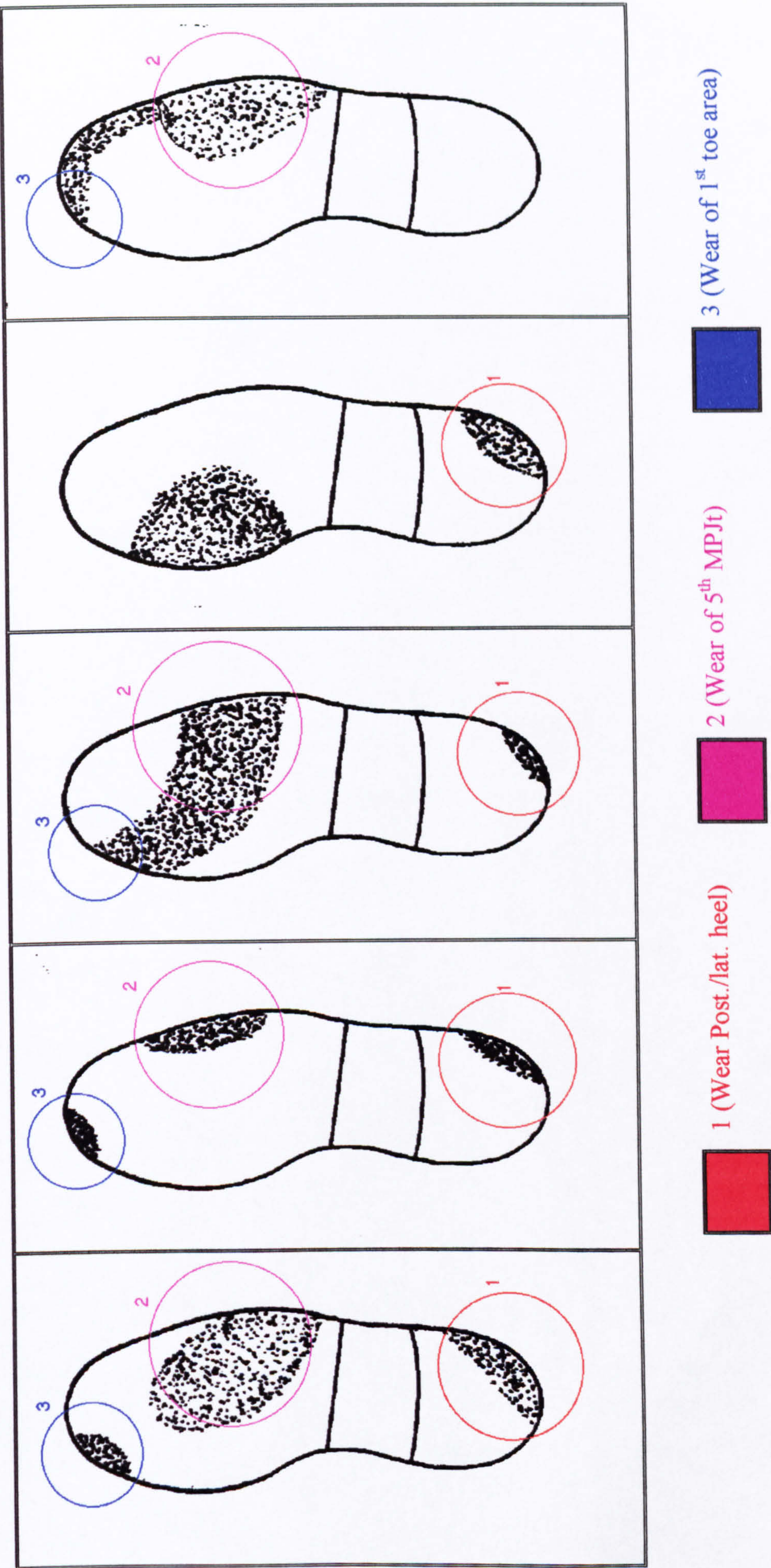
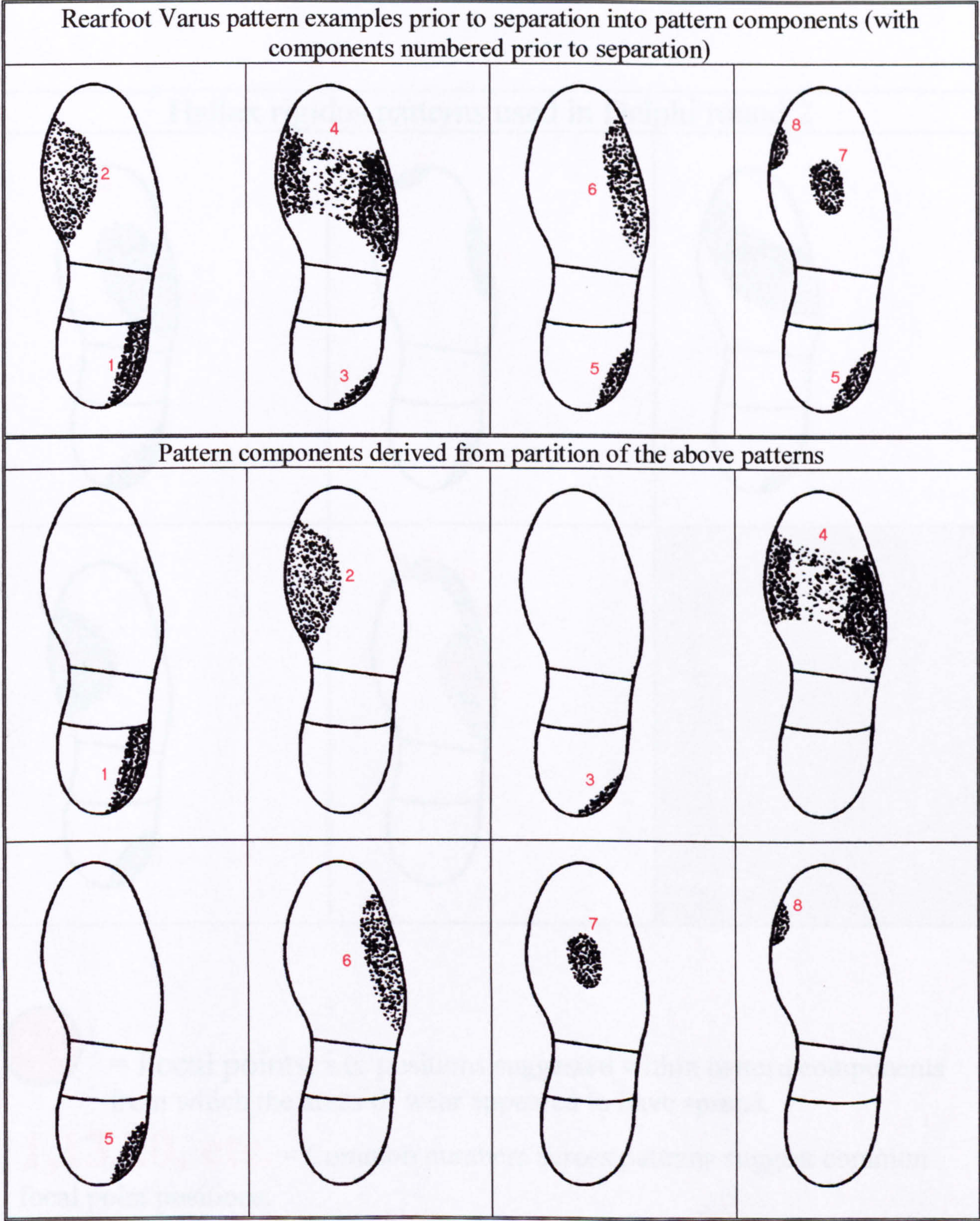
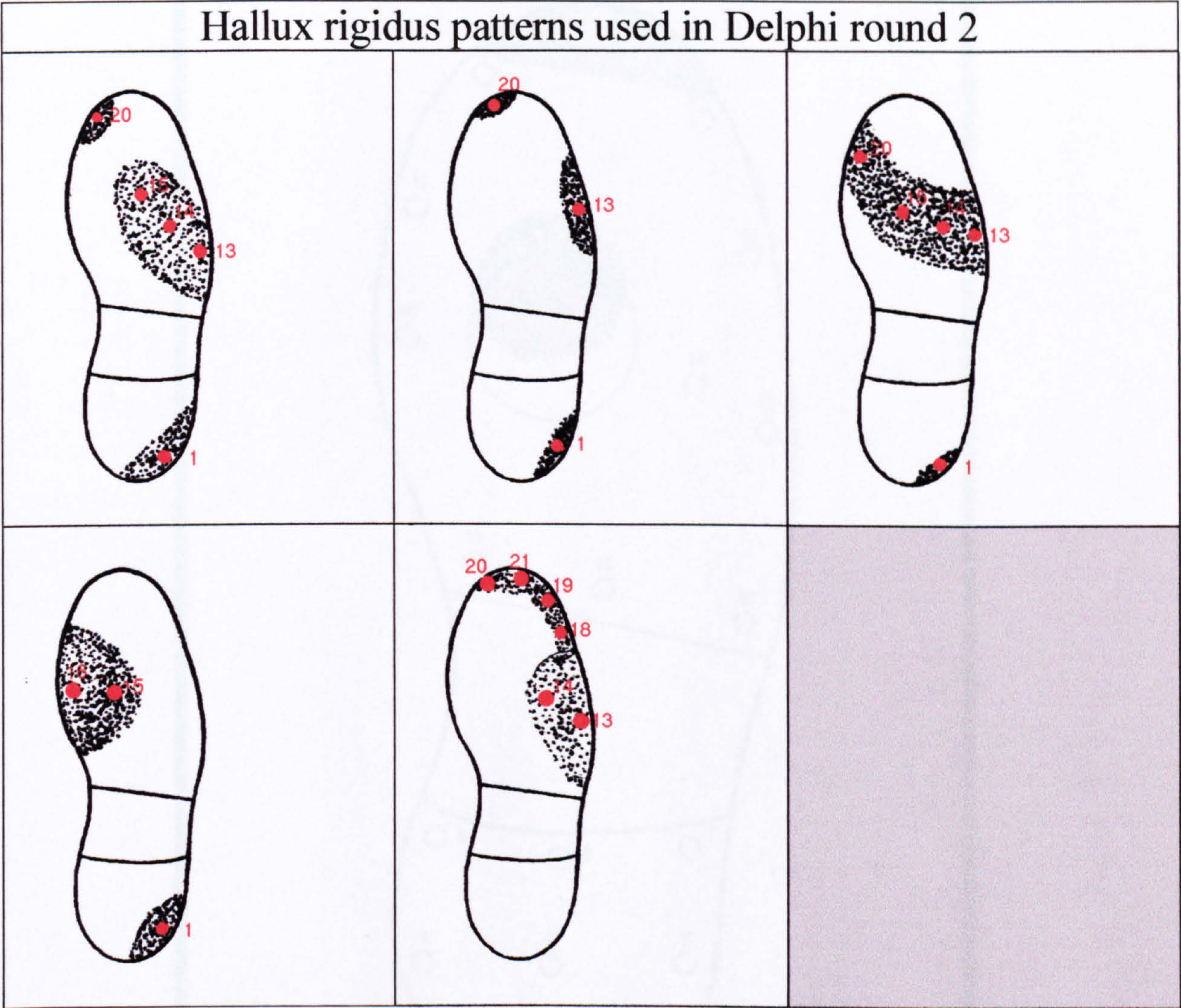


DIAGRAM 6 Examples of breakdown of patterns into pattern components



1,2,3, etc. = pattern component numbers

DIAGRAM 7 Similarities observed between the locations of wear pattern components of the shoe outsole



= Focal points, i.e. positions suggested within pattern components from which the areas of wear appeared to have spread.

1,13,20, etc. = Common numbers across patterns suggest common focal point positions.

DIAGRAM 8 Example of instrument in use with pattern 7

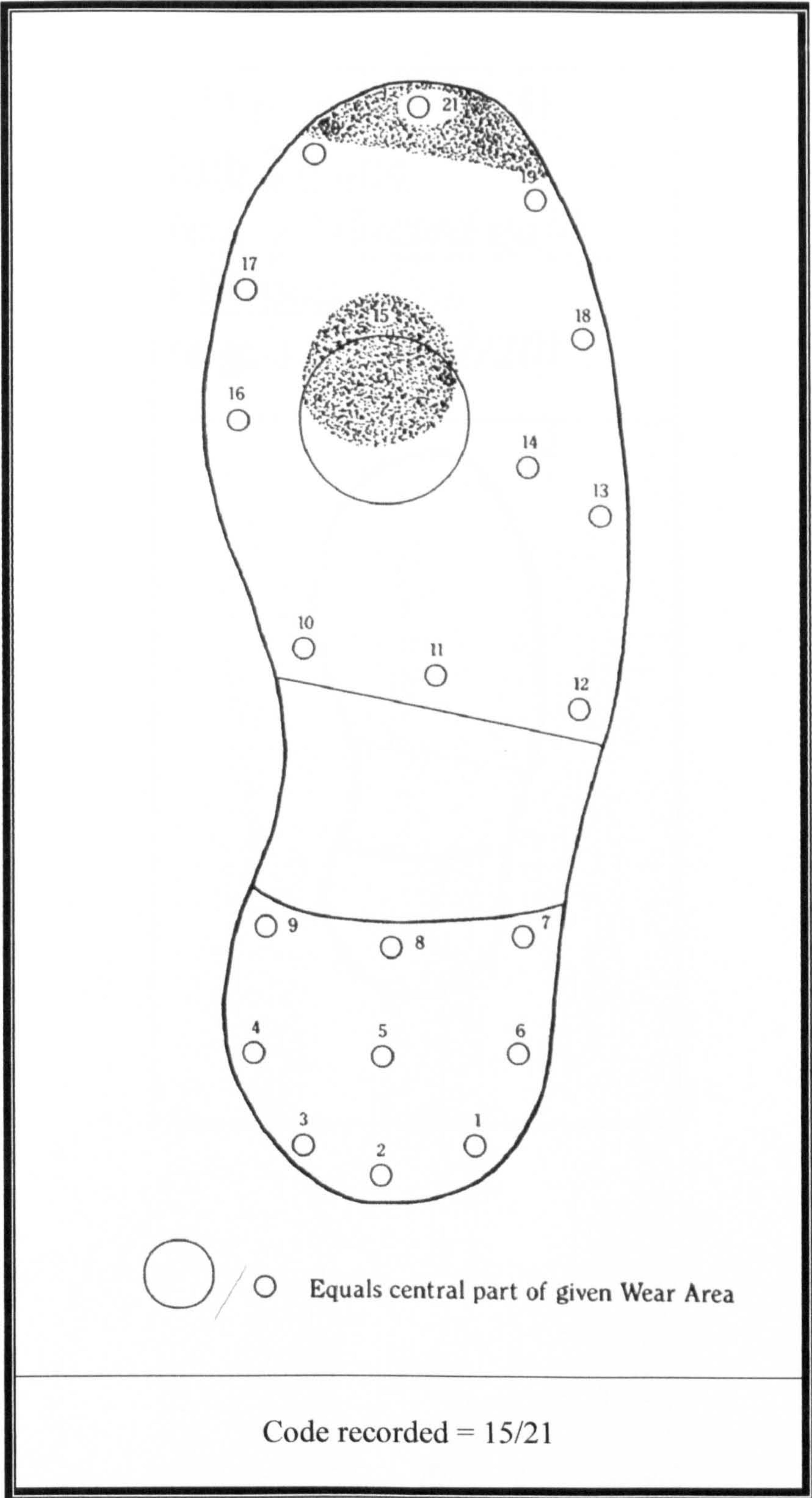


DIAGRAM 9 Collation card used for data analysis


I/D (<i>e.g. HR 48/3</i>)
<u>Sub Theme</u> (<i>e.g. Abducted gait</i>)
<u>FPCode</u> (<i>e.g. 1/9/16/17/20</i>)


DIAGRAM 10 Factors considered when contemplating functions associated with wear patterns within a known context

In order to classify foot function the following aspects were considered :

ASPECT FOR CONSIDERATION	MINUS	CENTRAL DESCRIPTION	PLUS	ADDITIONAL COMMENT
Gait Angle	Adducted	Normal	Abducted	
Rearfoot Inclination	Inverted	Normal	Everted	Everted = Unstable
Forefoot Inclination	Inverted	Normal	Everted	Everted = Unstable
Heel to Forefoot Angle	Low	Normal	High	
Torsional Effects	Adductory Twist	Normal	Abductory Twist	
Forefoot Curvature	Concave	Normal	Convex	
DIRECT PATHOLOGICAL EFFECT	Anticipated		Not anticipated	
	Restrictive (Pathology allows effect by causing deviation)		Submissive (Pathology allows effect through excessive passivity)	
	Corrected (Opposing sign through foot attempting to do the opposite)	Controlled (indirect sign through other aspect of foot attempting control)	Accommodated (no sign – anticipated)	

(This system may have the potential to form the basis of a sub-classification system for the podiatric description of states affecting the foot).

DIAGRAM 11 Basic model of hierarchical relationship of shoe wear influence

	Source of influence	Descending order of influence
Holistic function	Primary walking intention	↓
	Foot pathology	
	External factors	

DIAGRAM 12 Shoe wear pattern influences

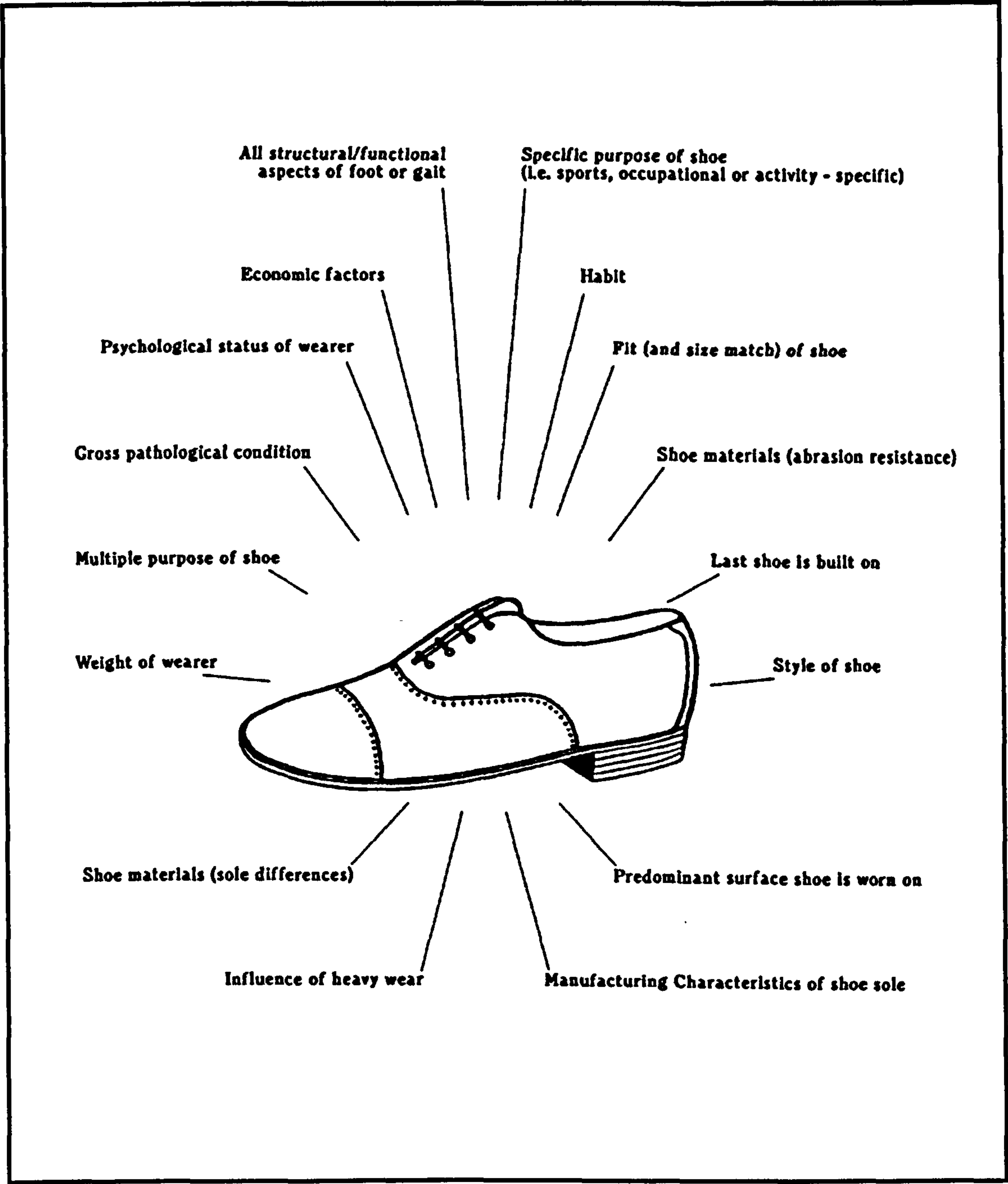


DIAGRAM 13 Functions suggested for subjects examined in the validation phase

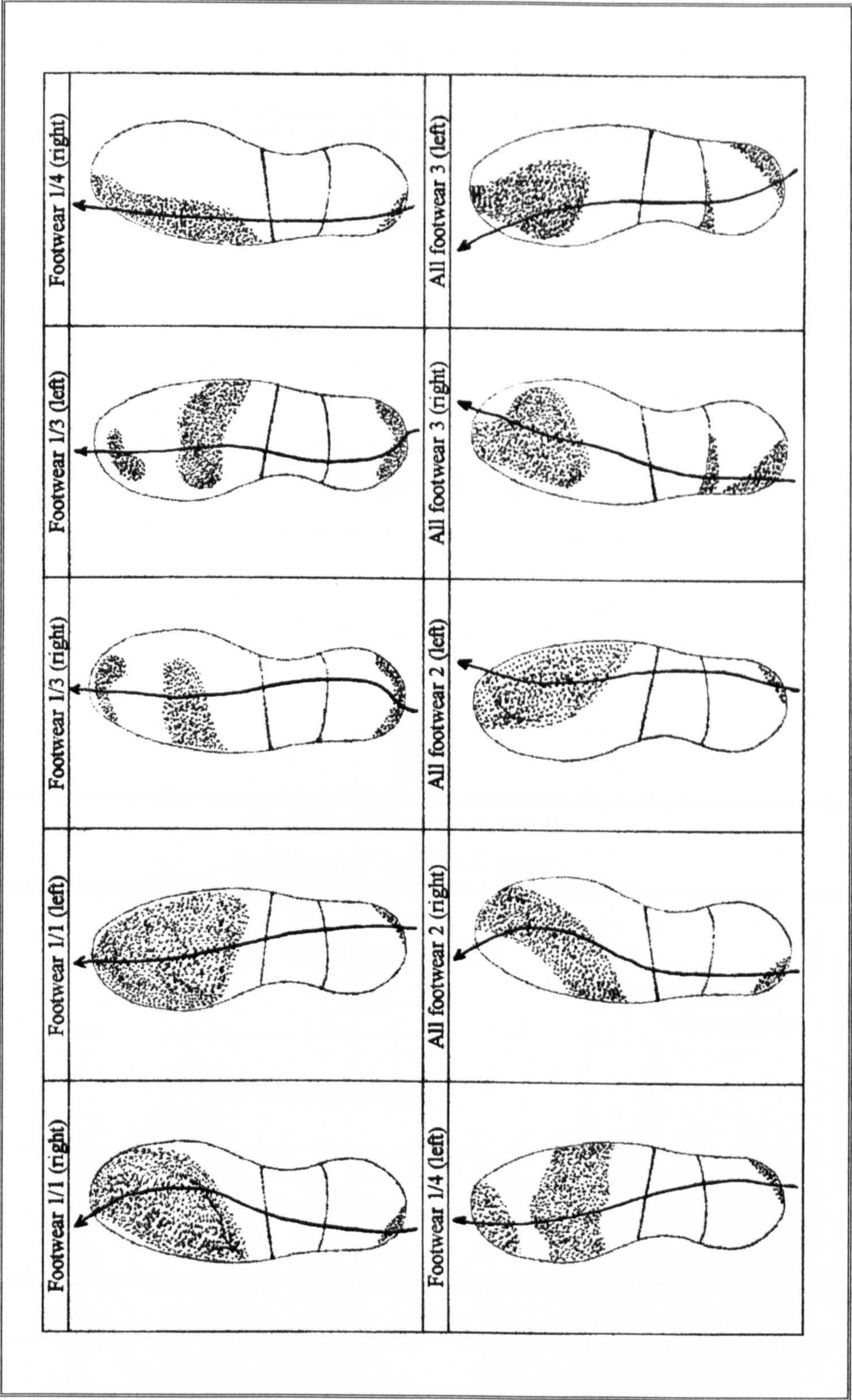
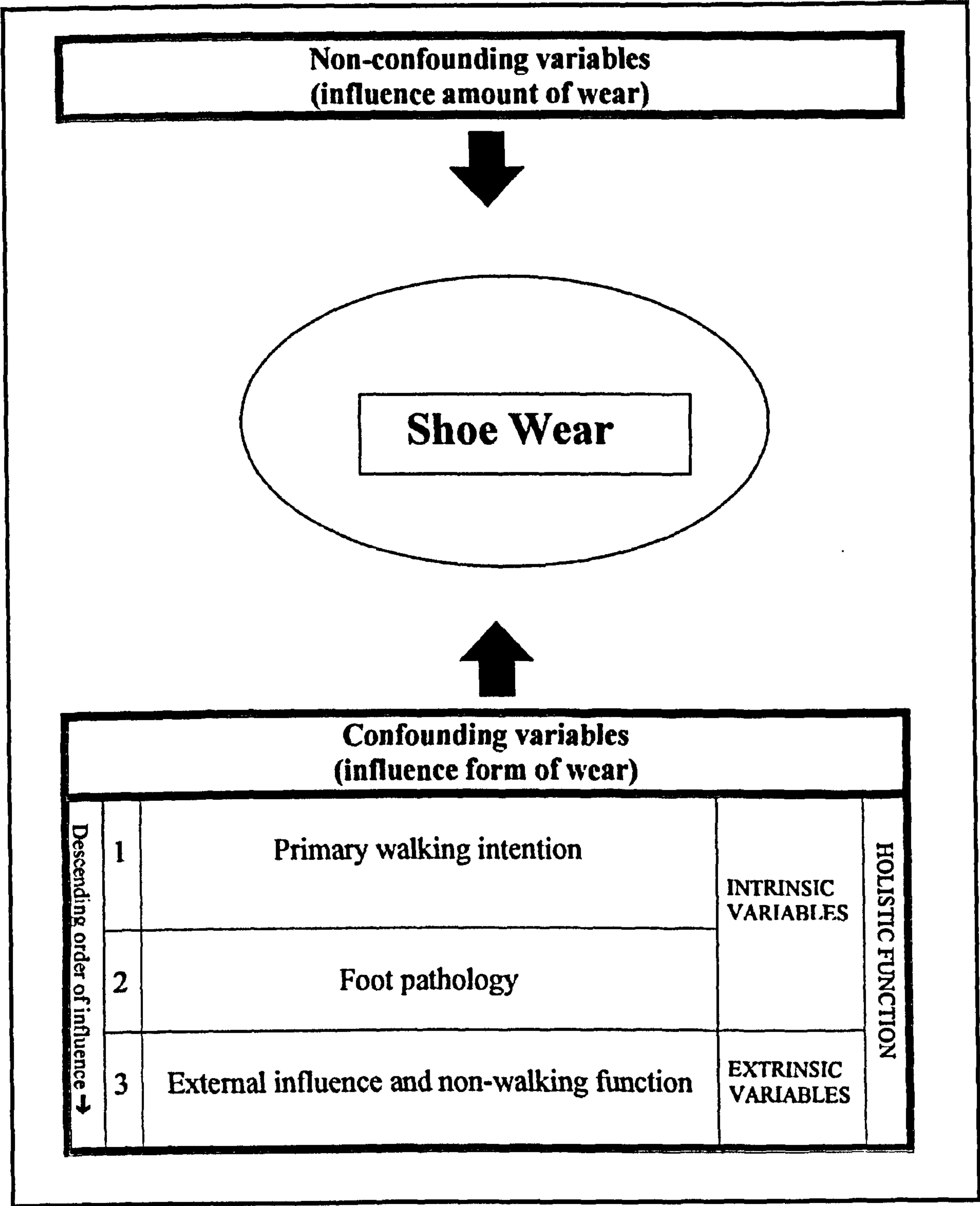
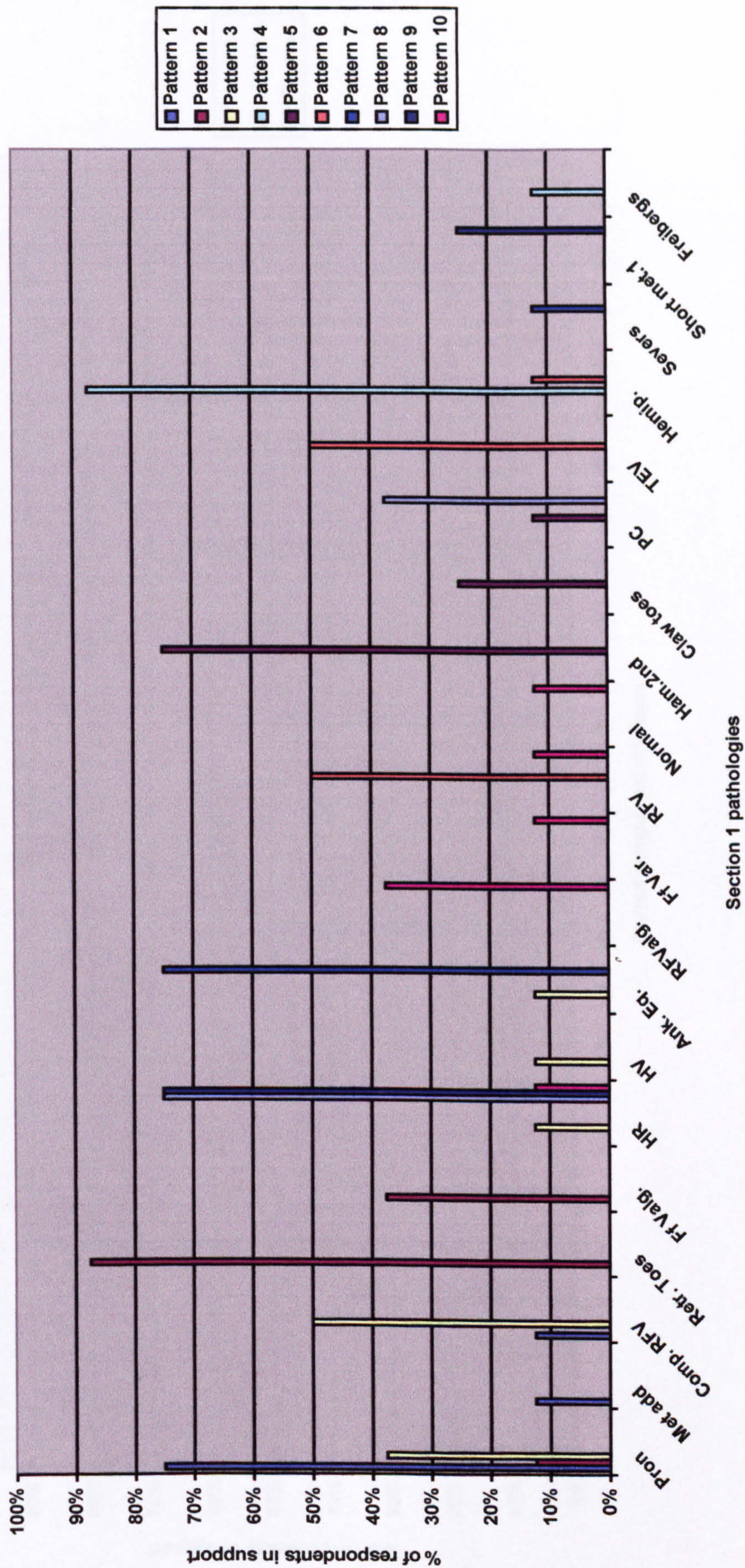


DIAGRAM 14 Model of shoe wear pattern influence

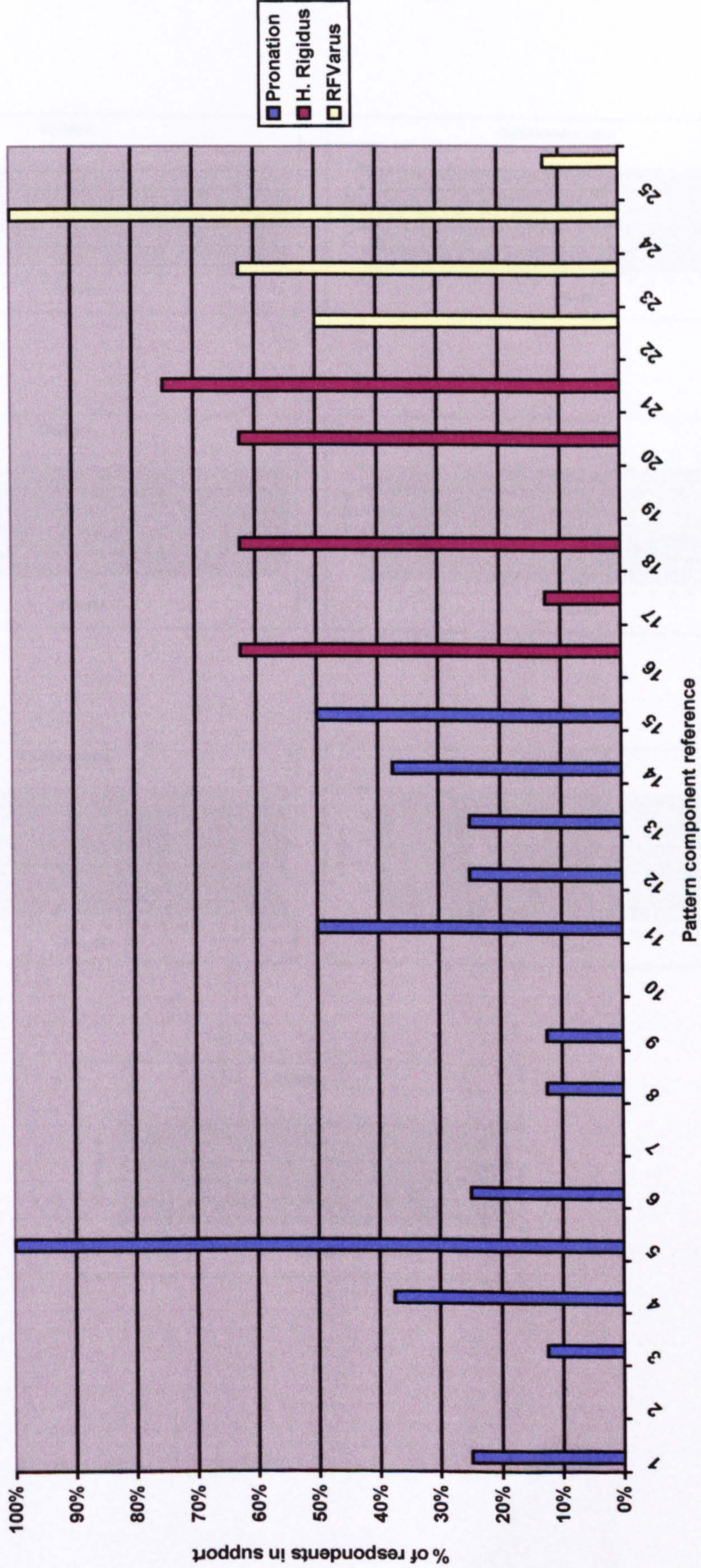


GRAPHS

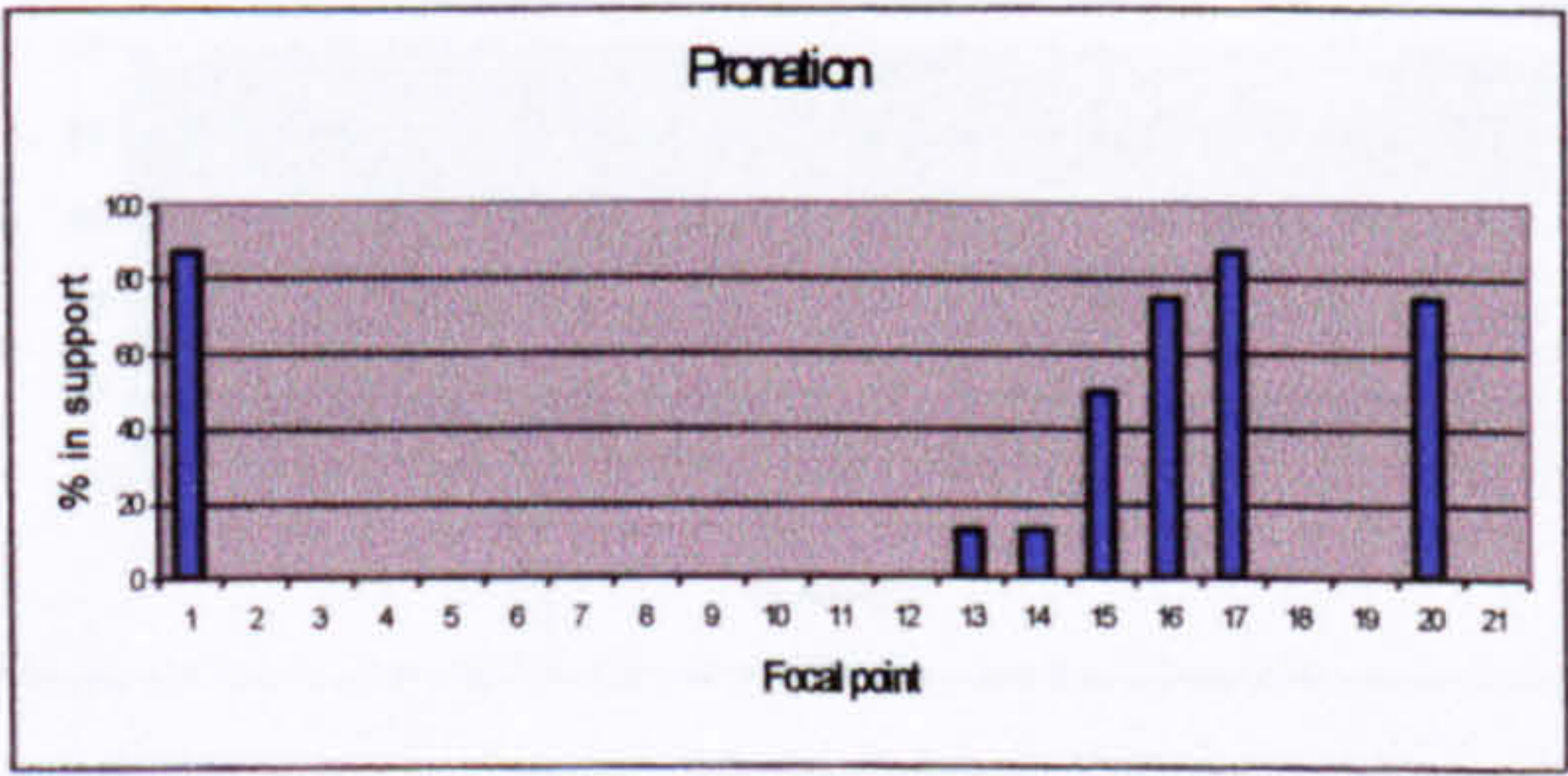
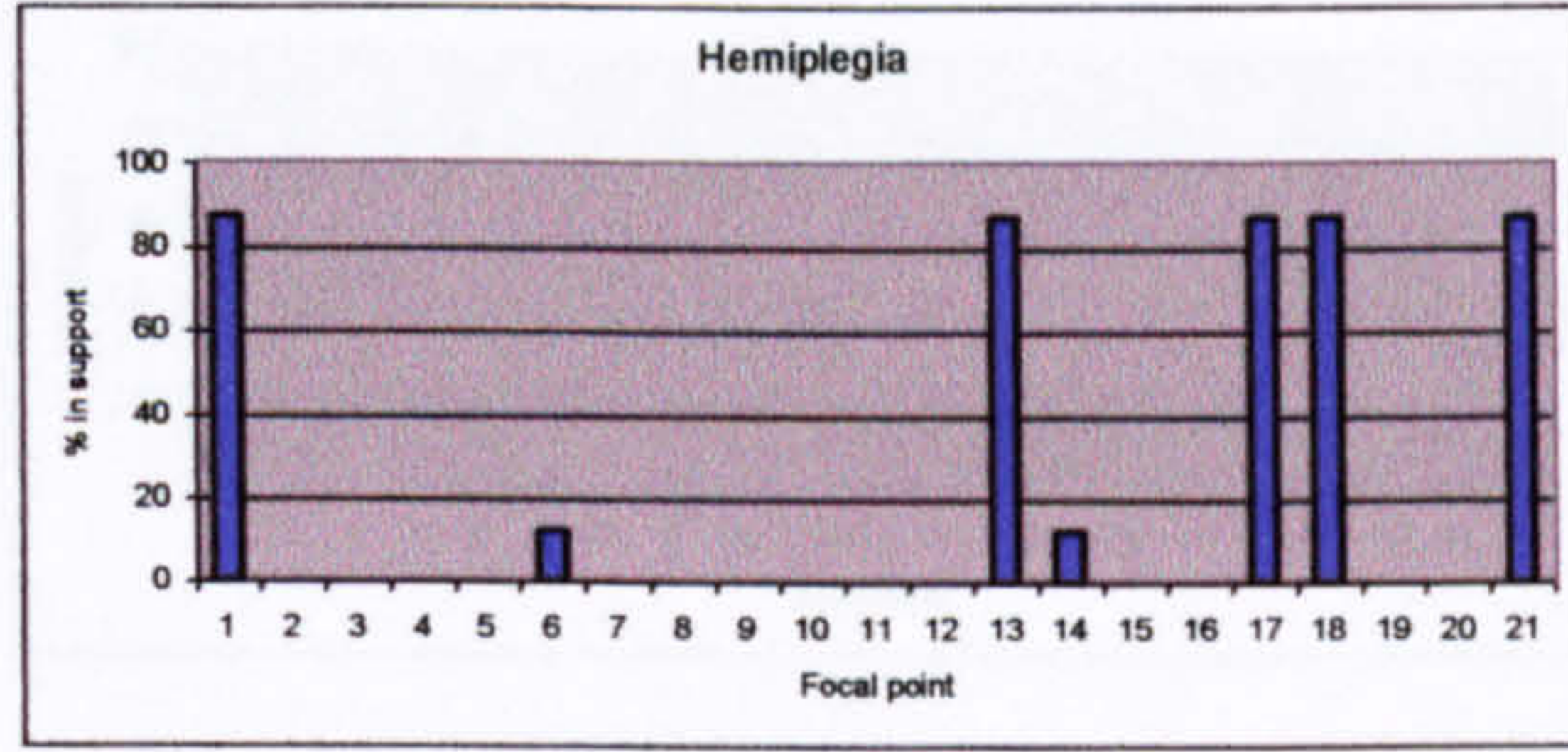
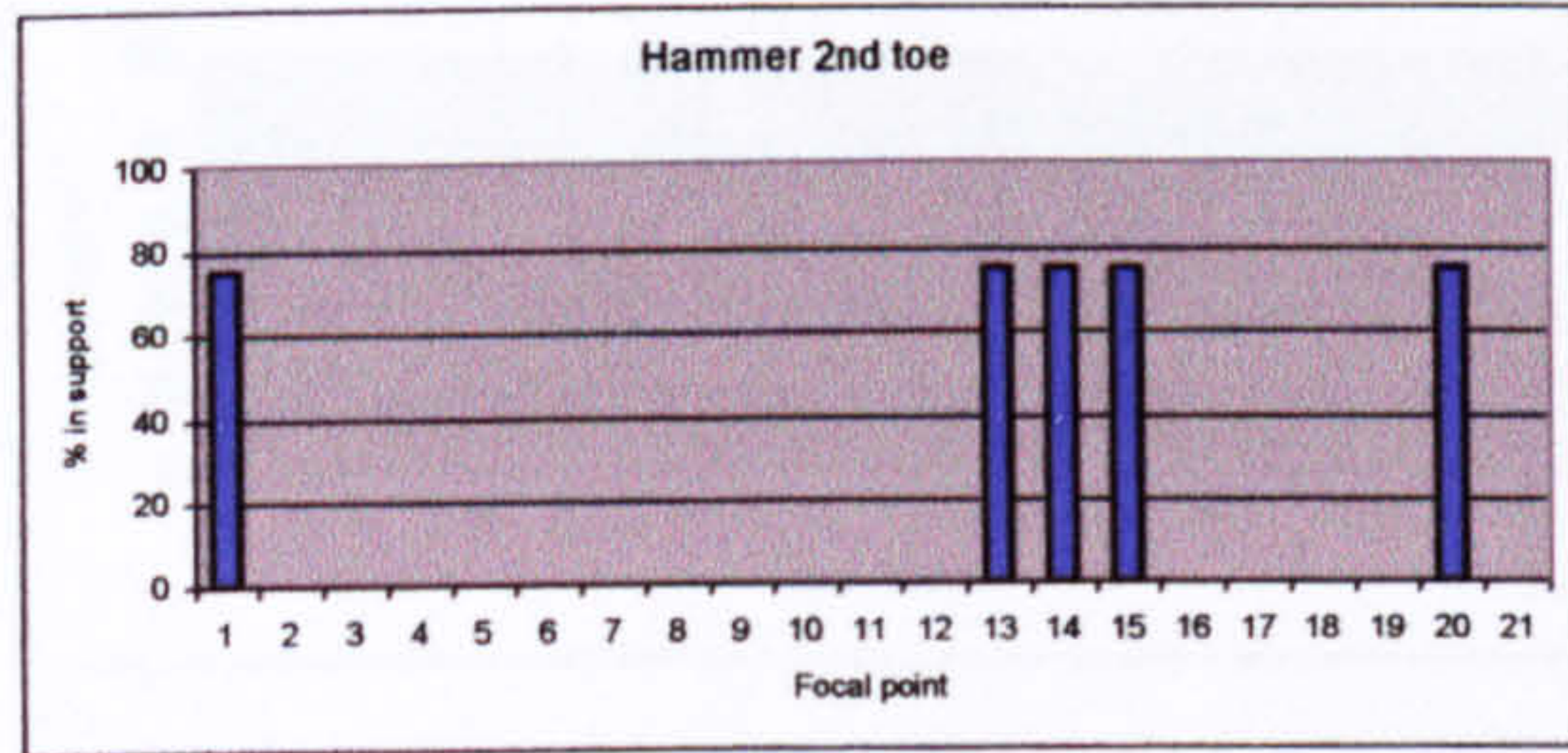
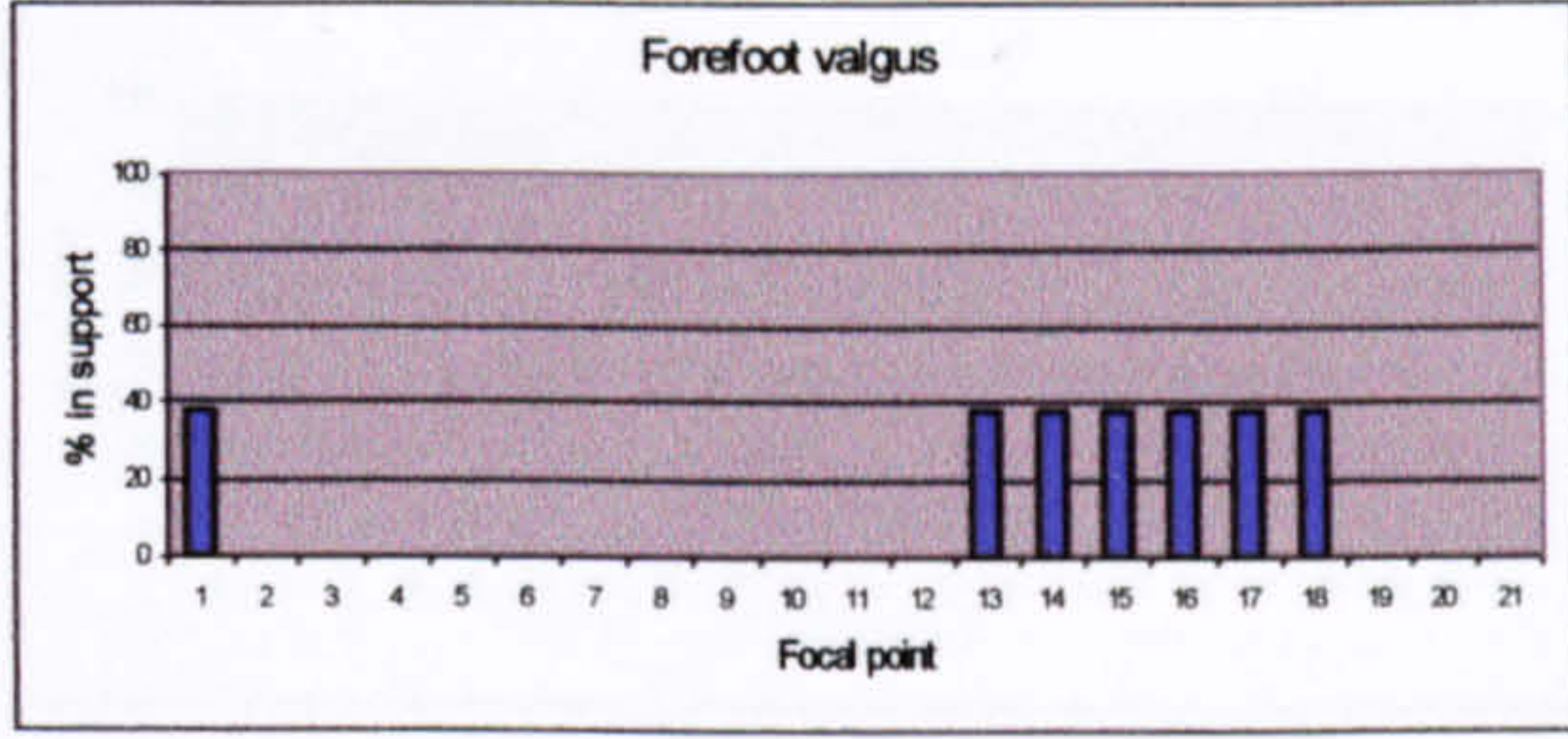
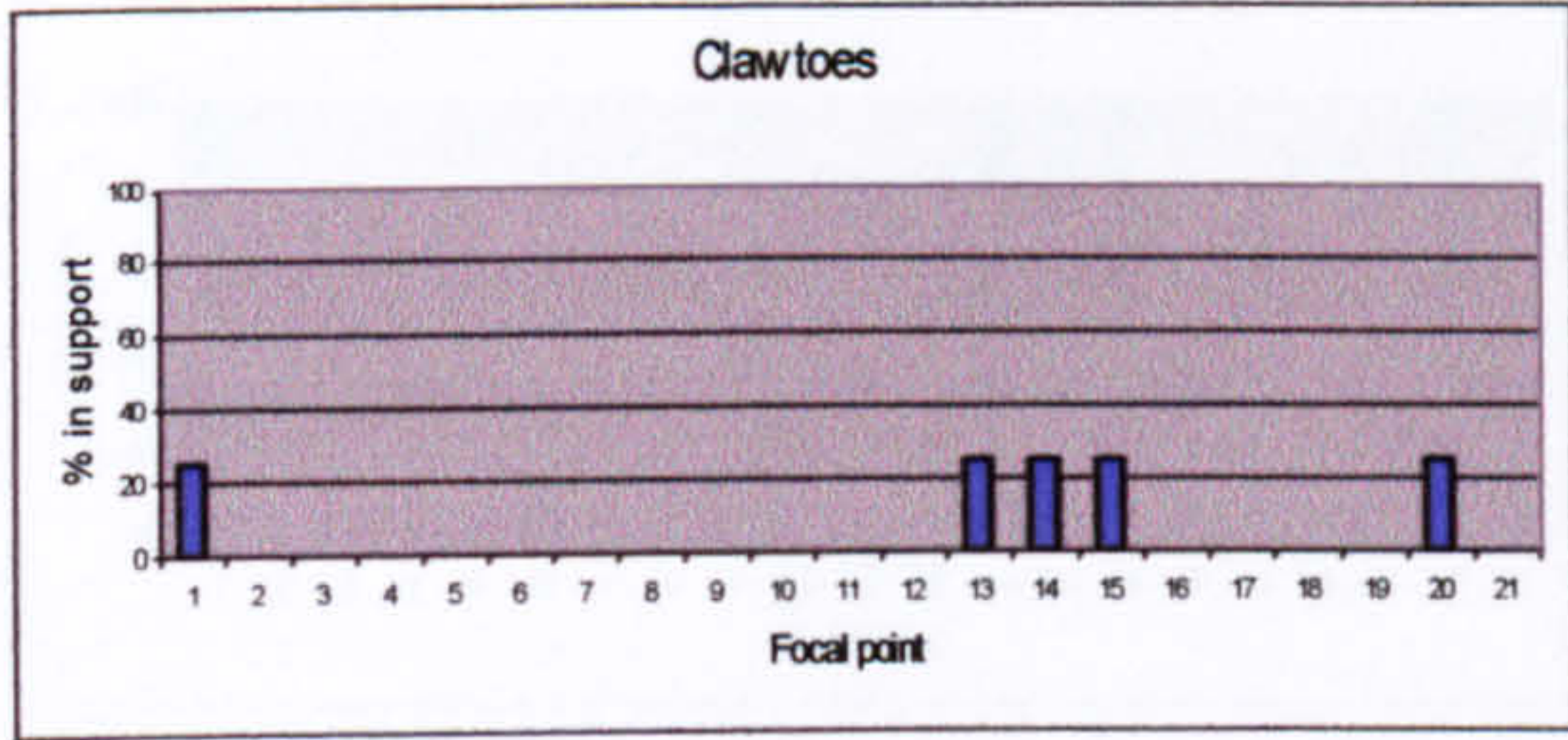
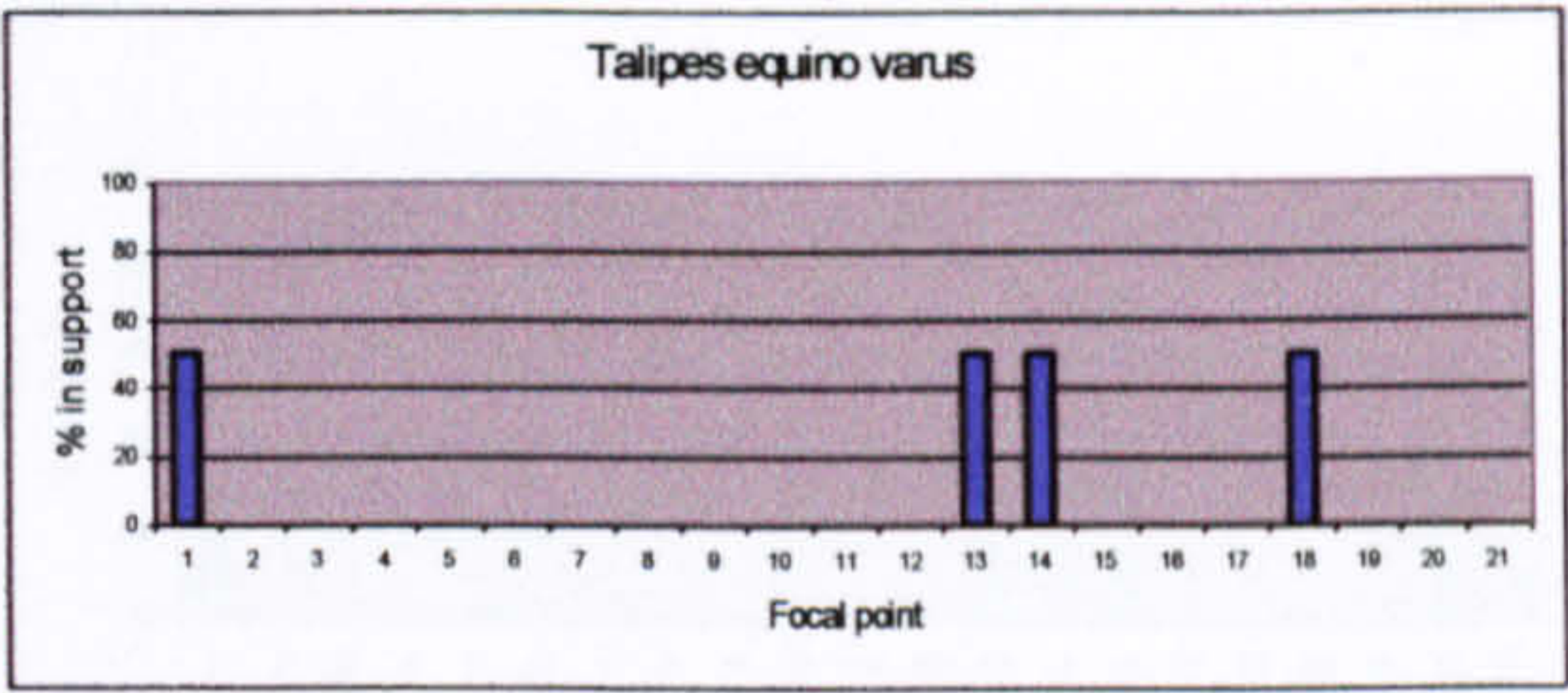
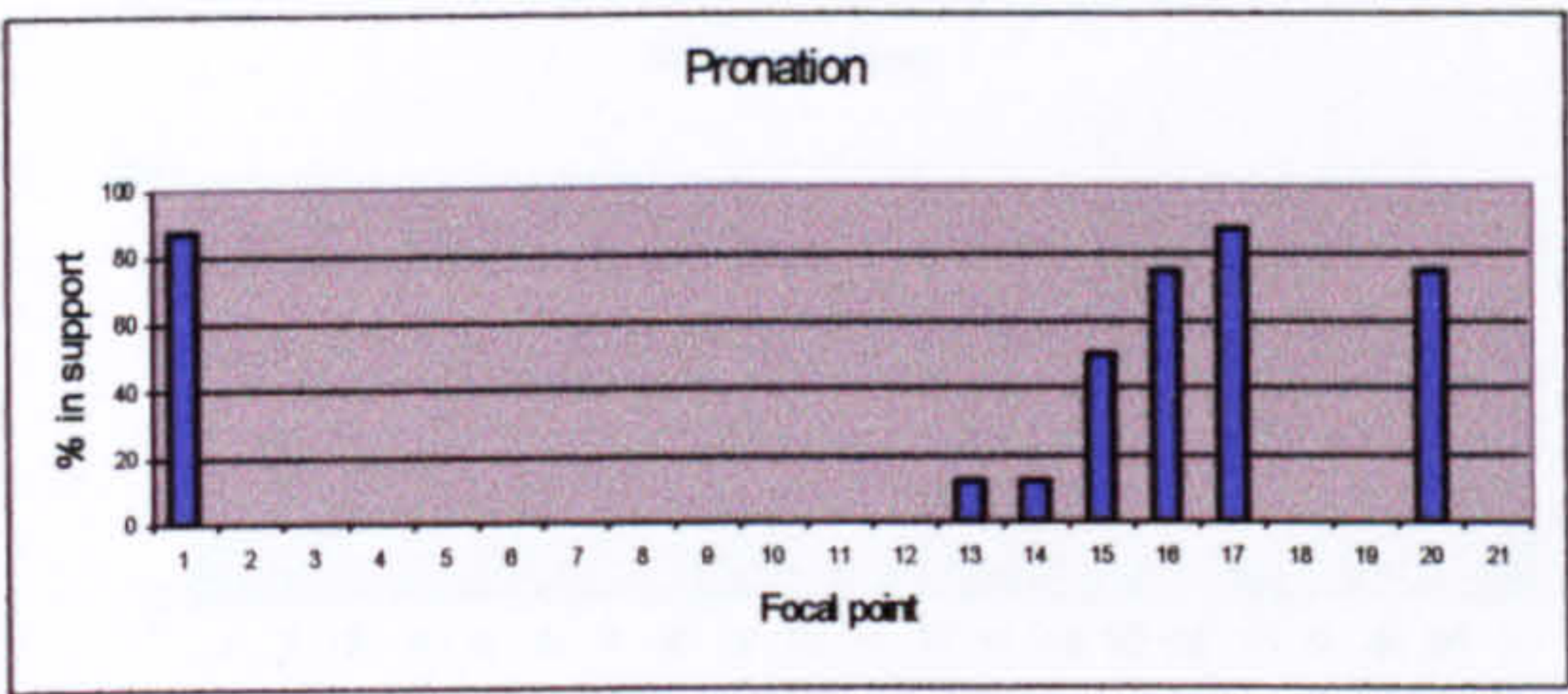
GRAPH 1 Face level consensus in Delphi round 2, section 1



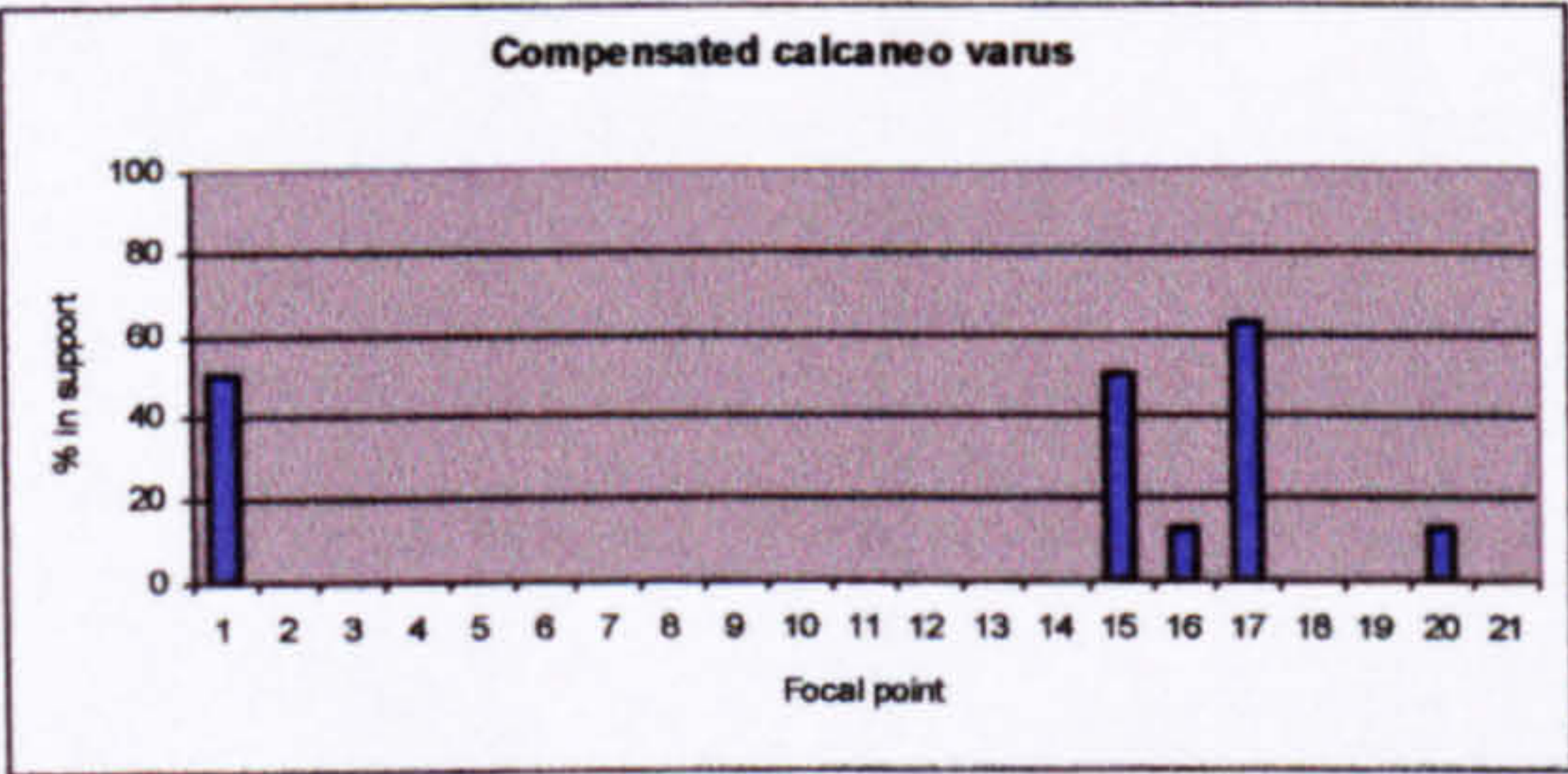
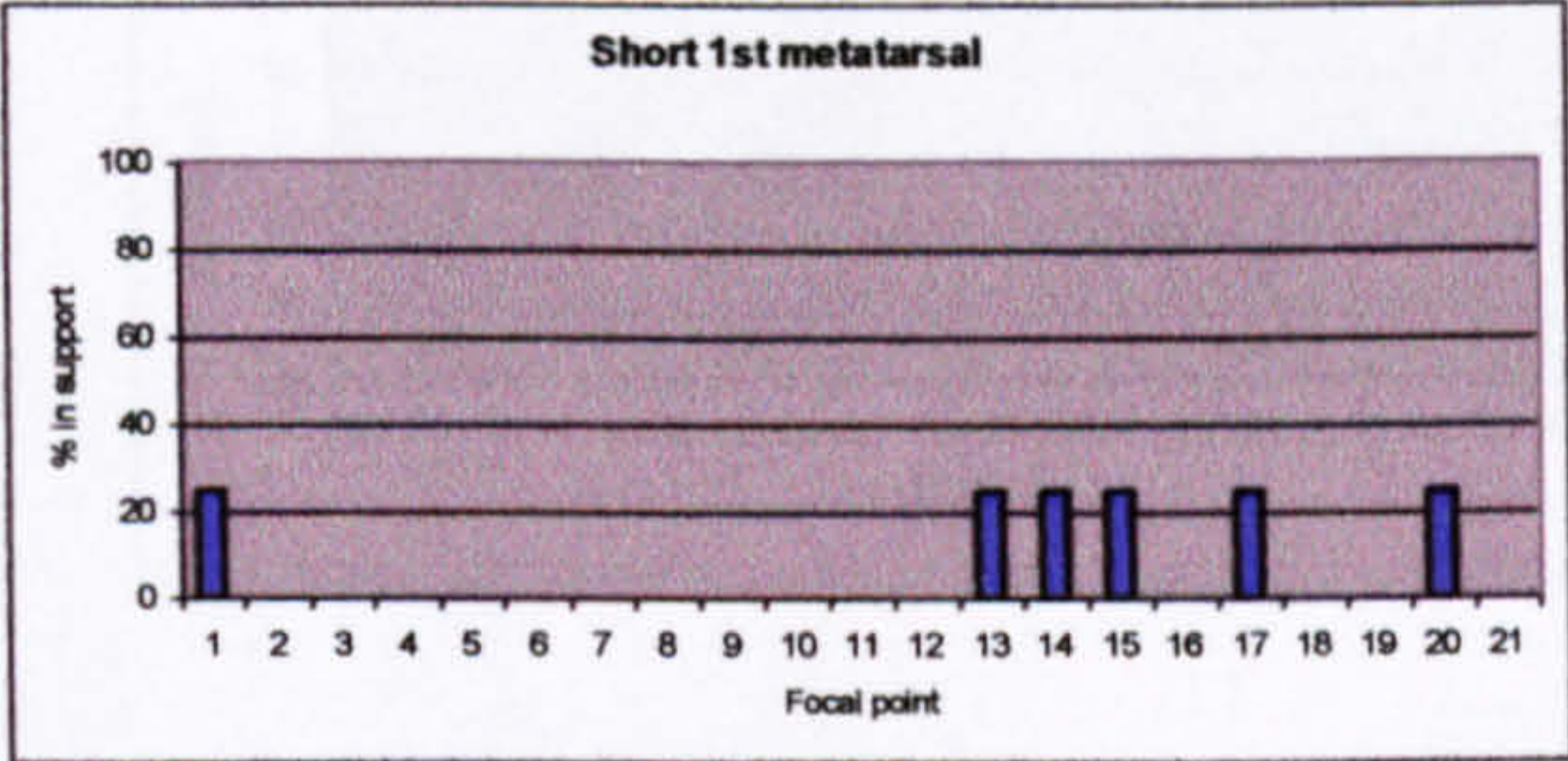
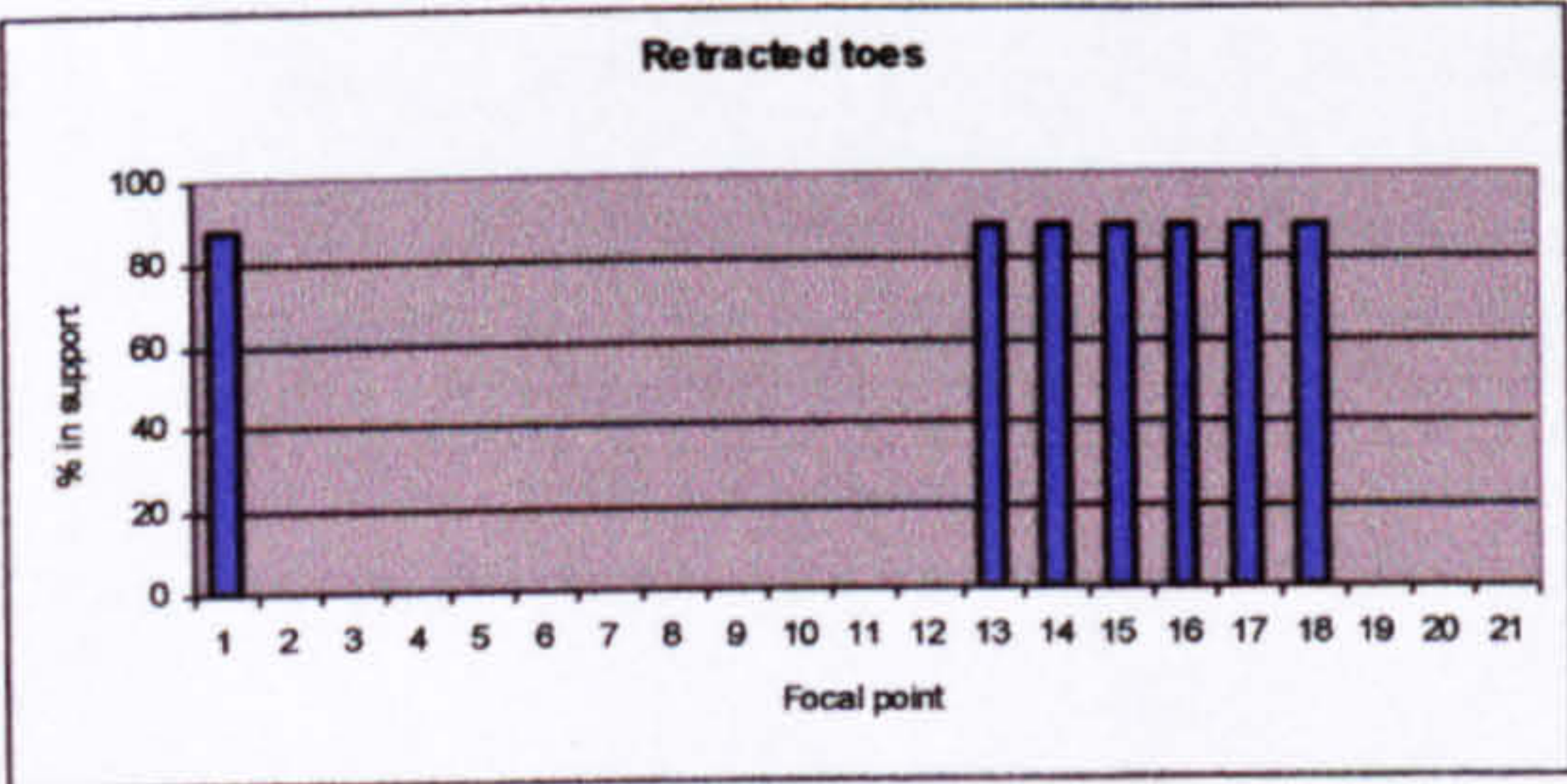
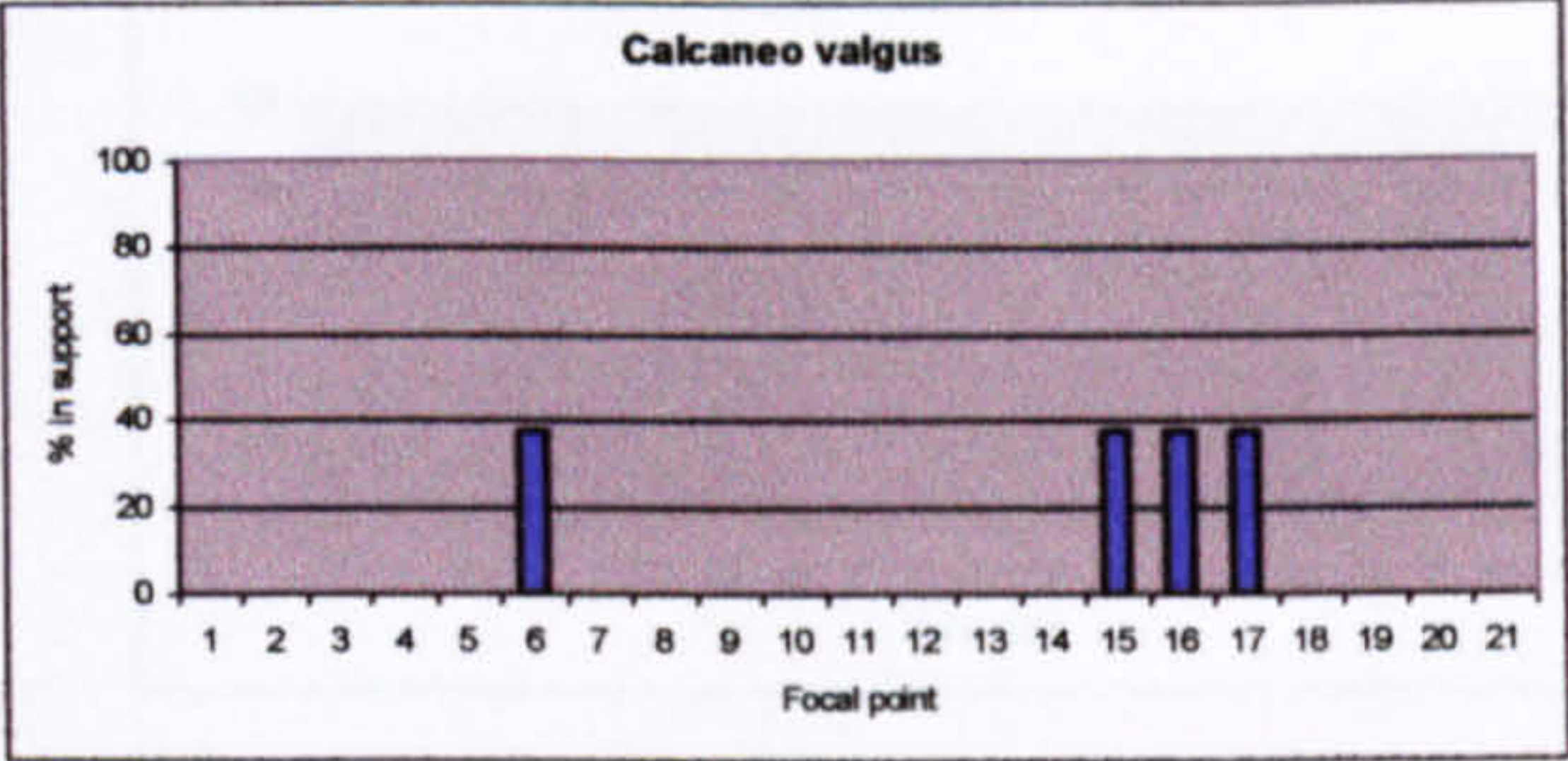
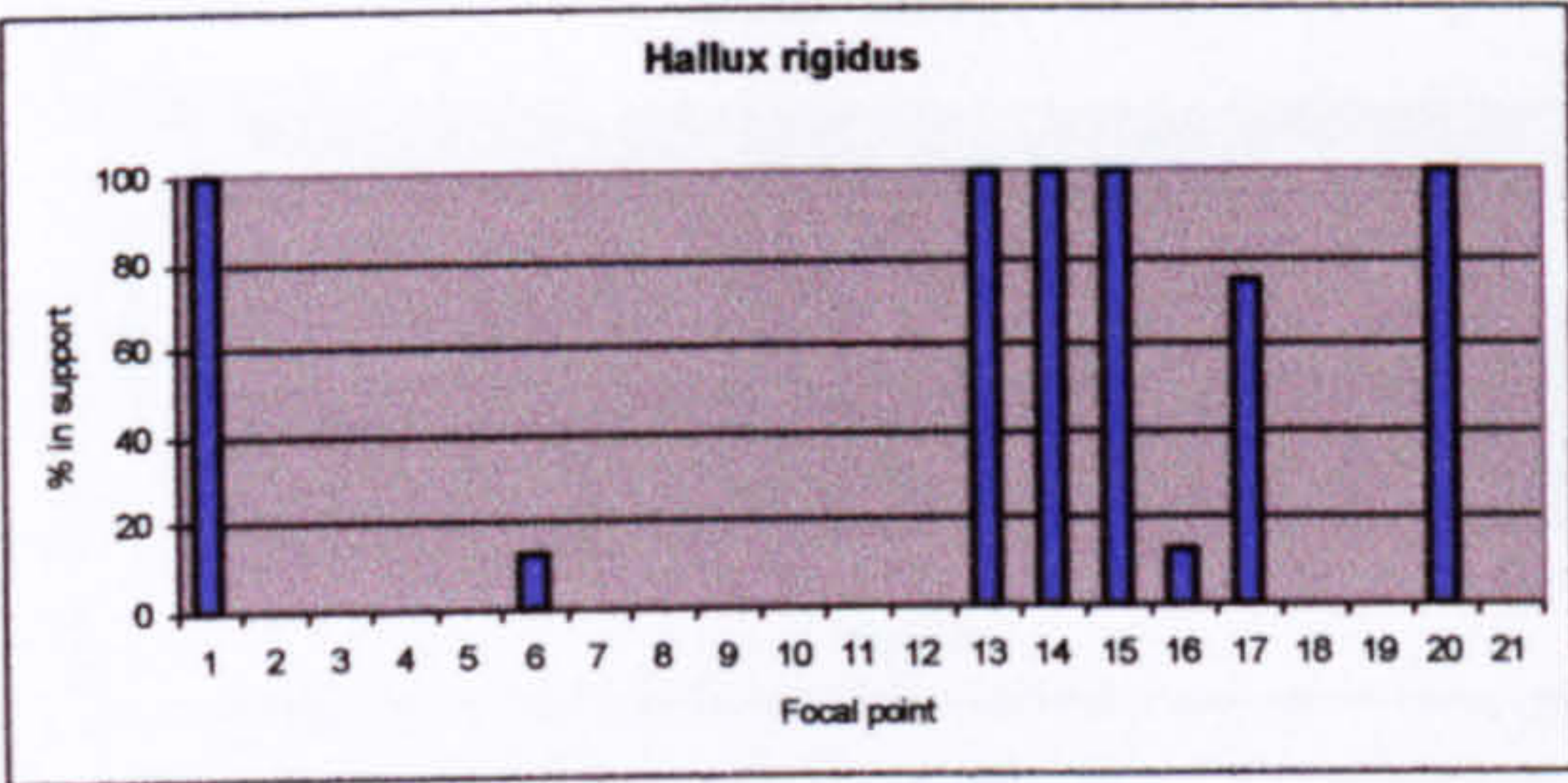
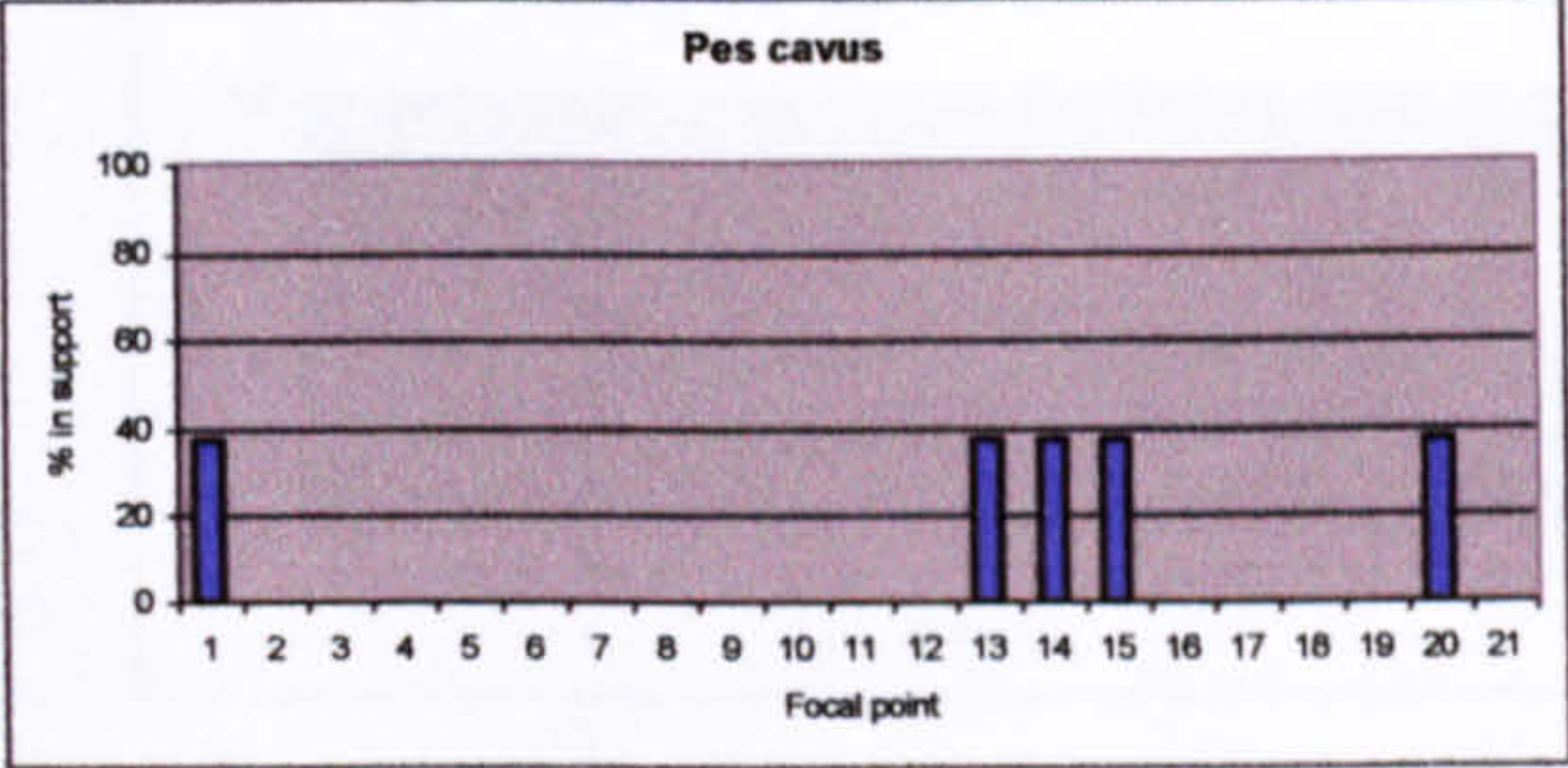
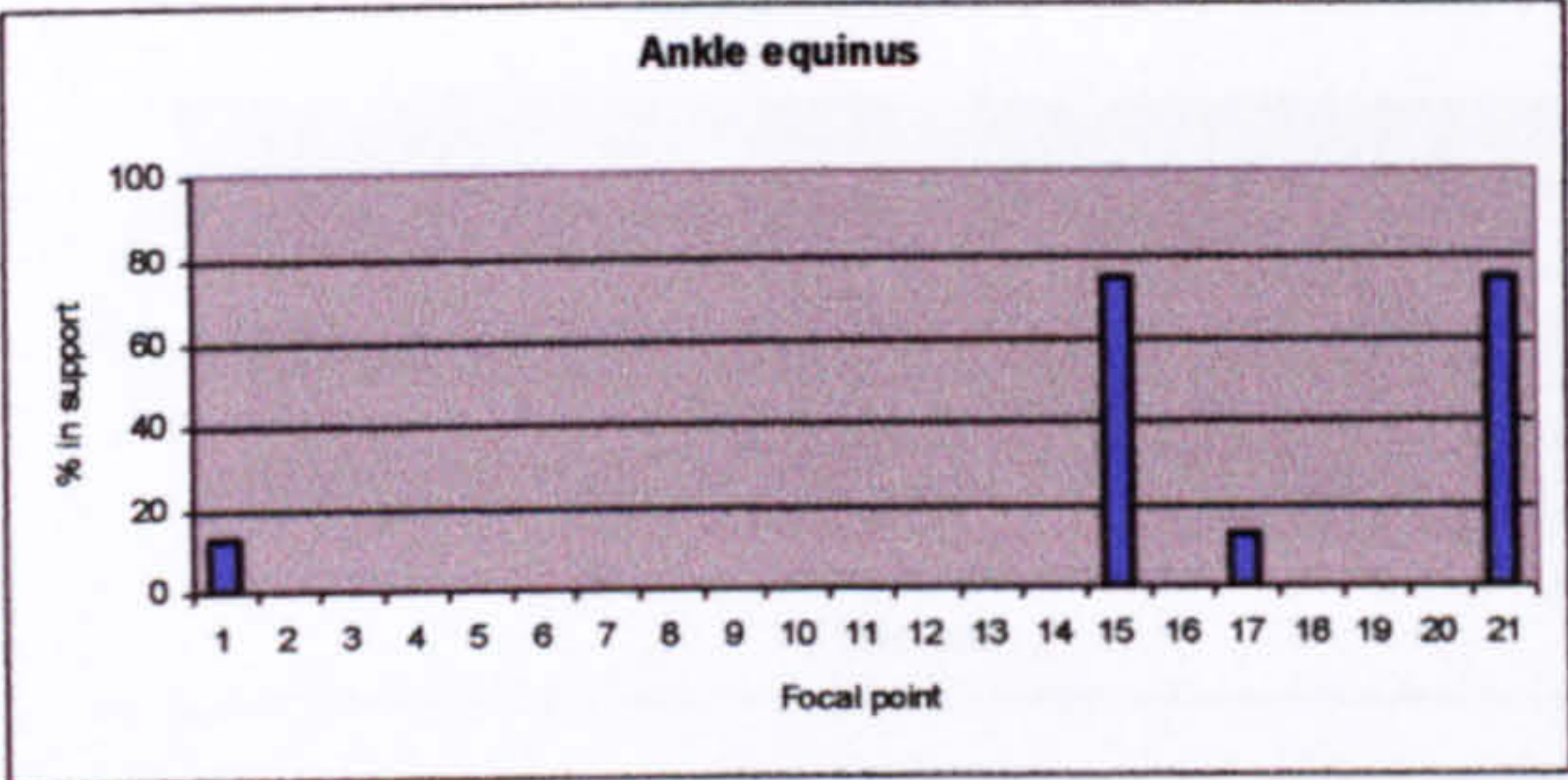
GRAPH 2 Face level consensus in Delphi round 2, section 2



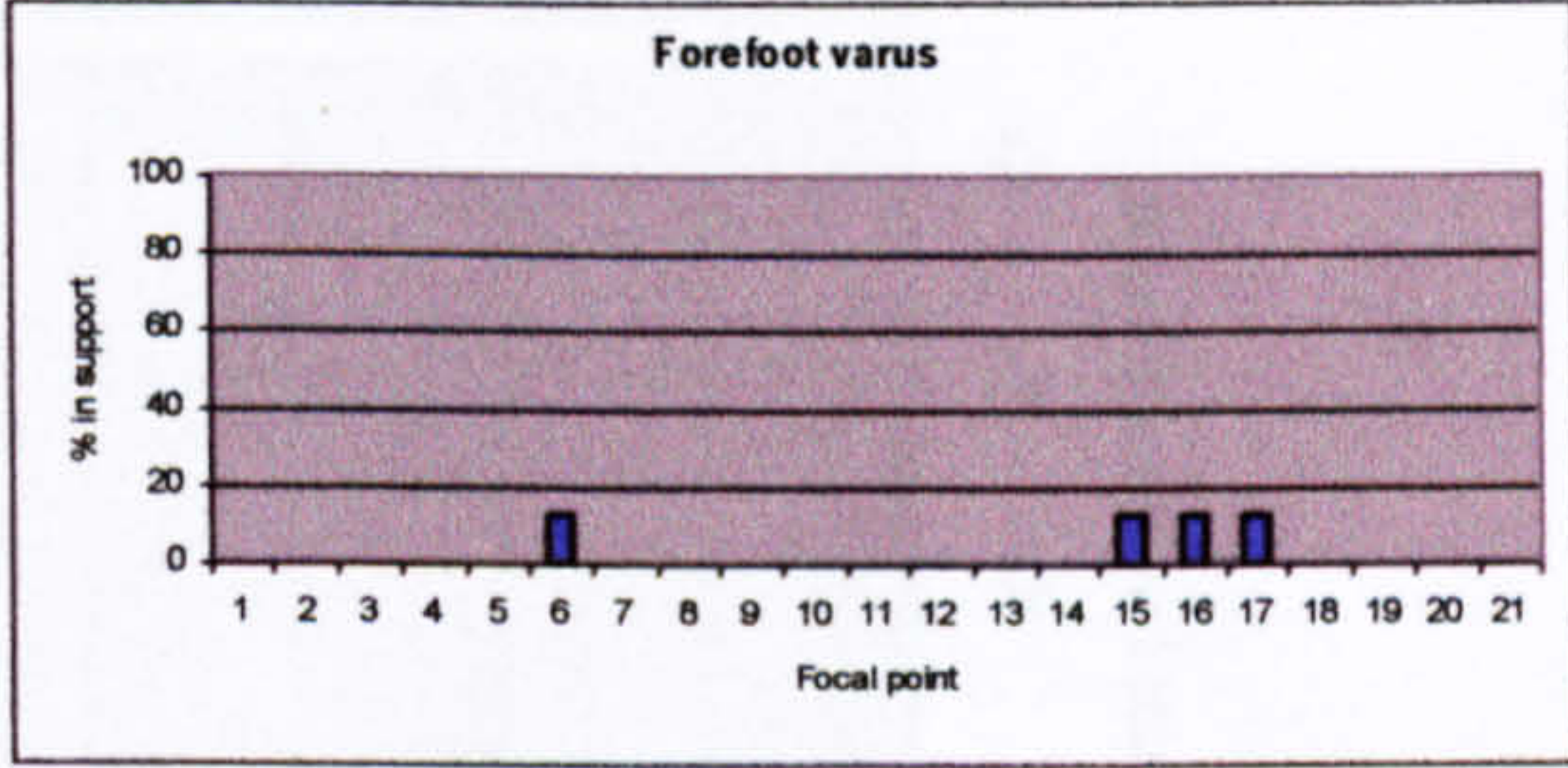
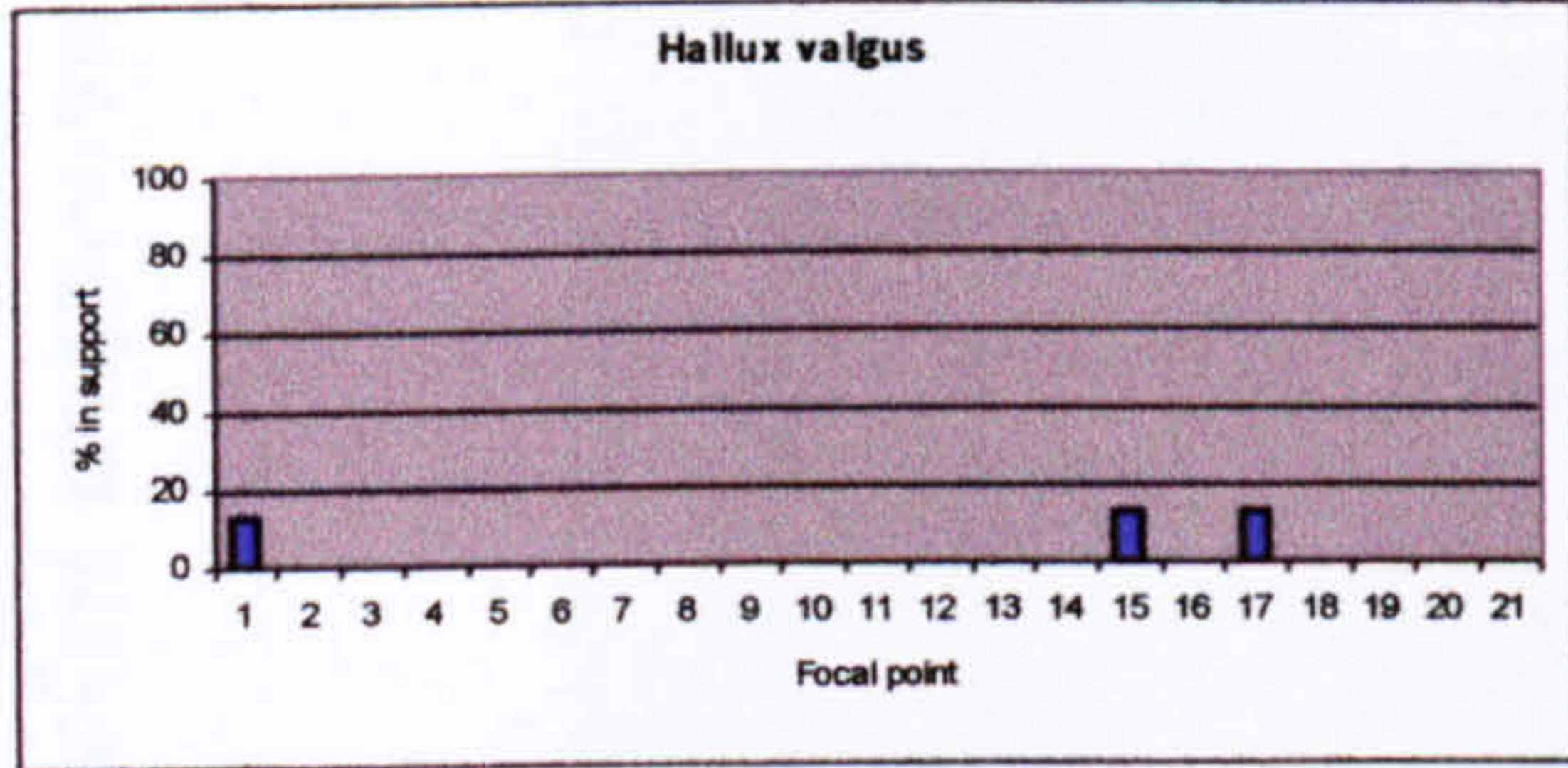
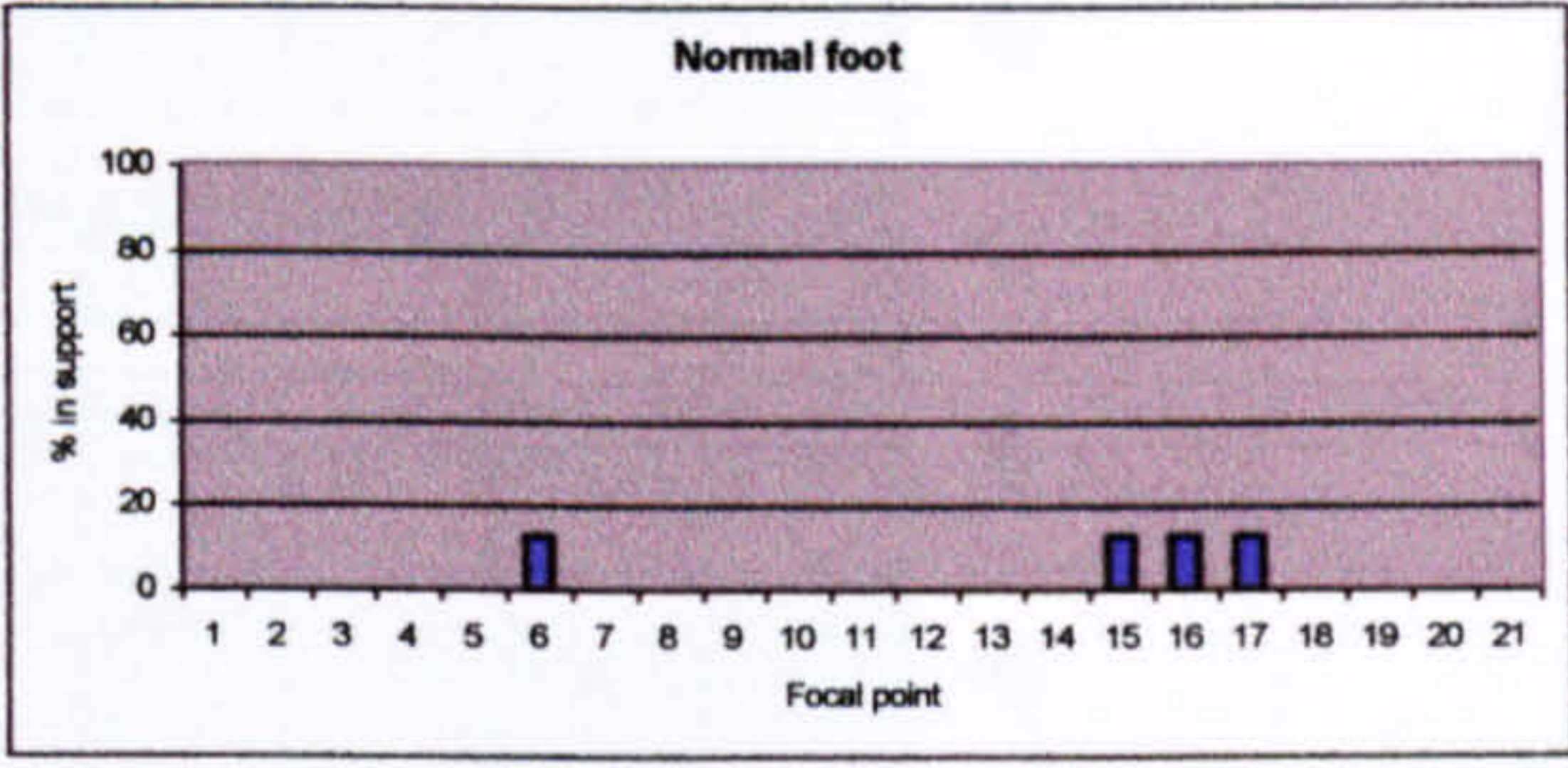
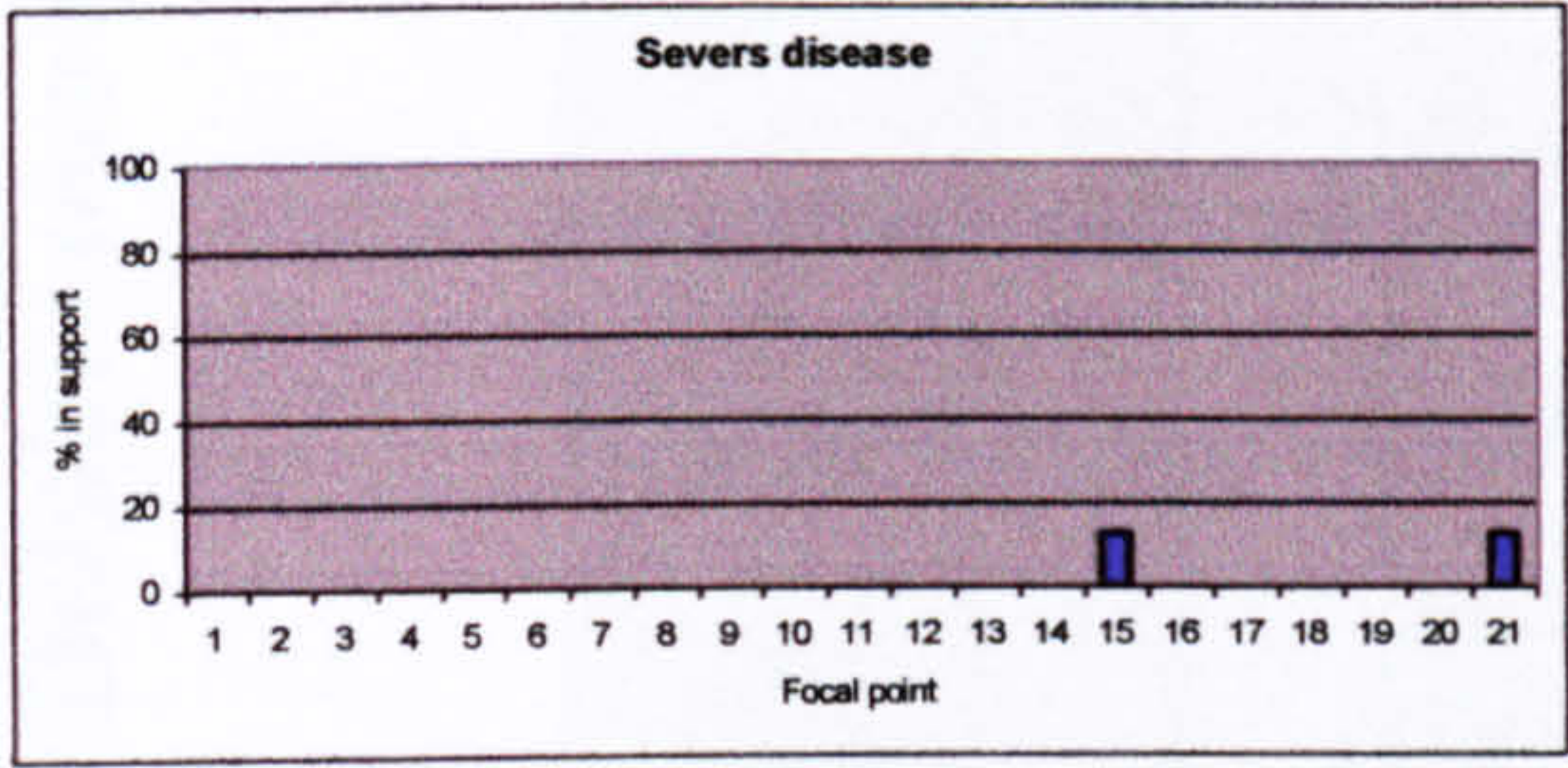
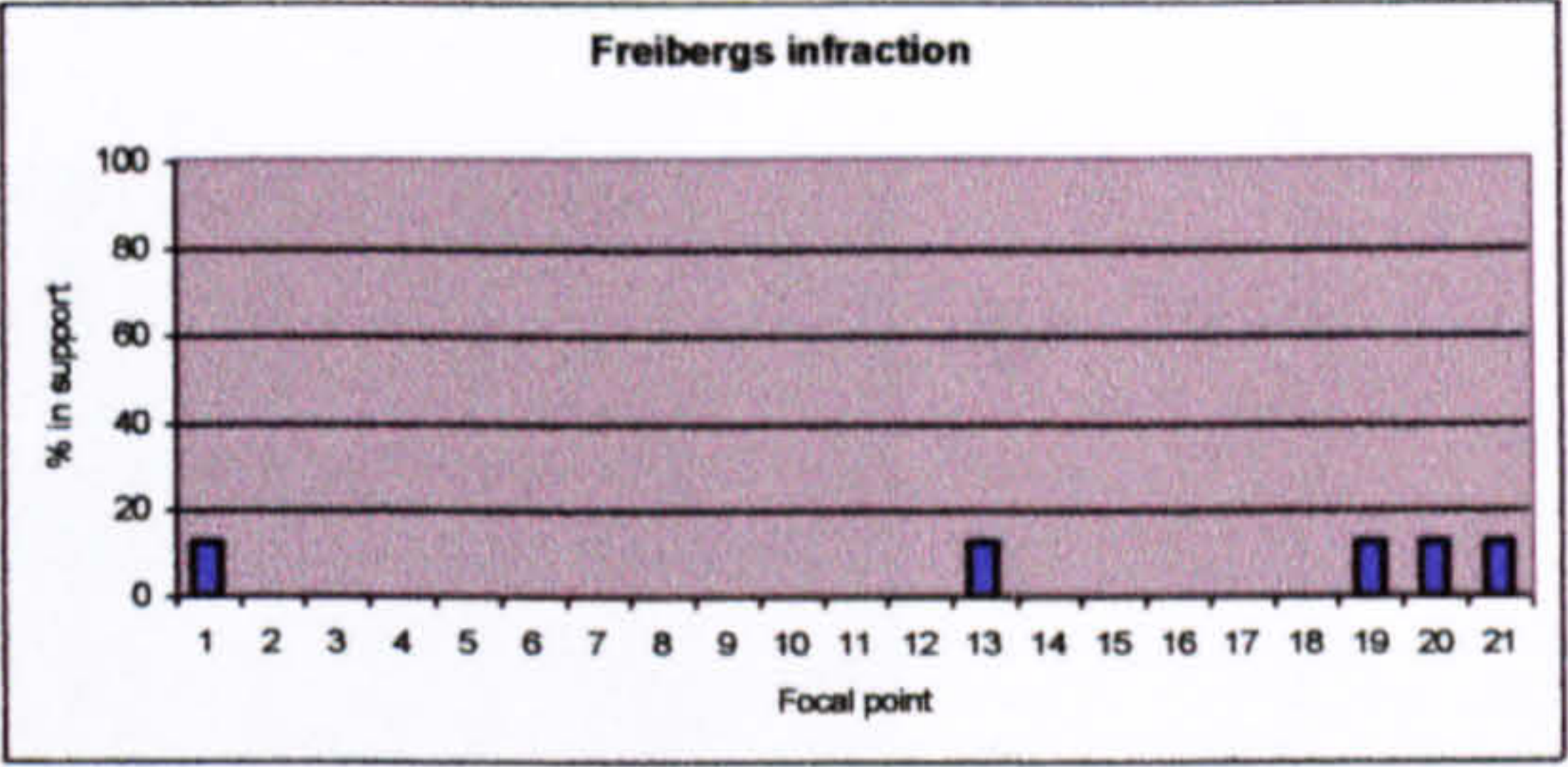
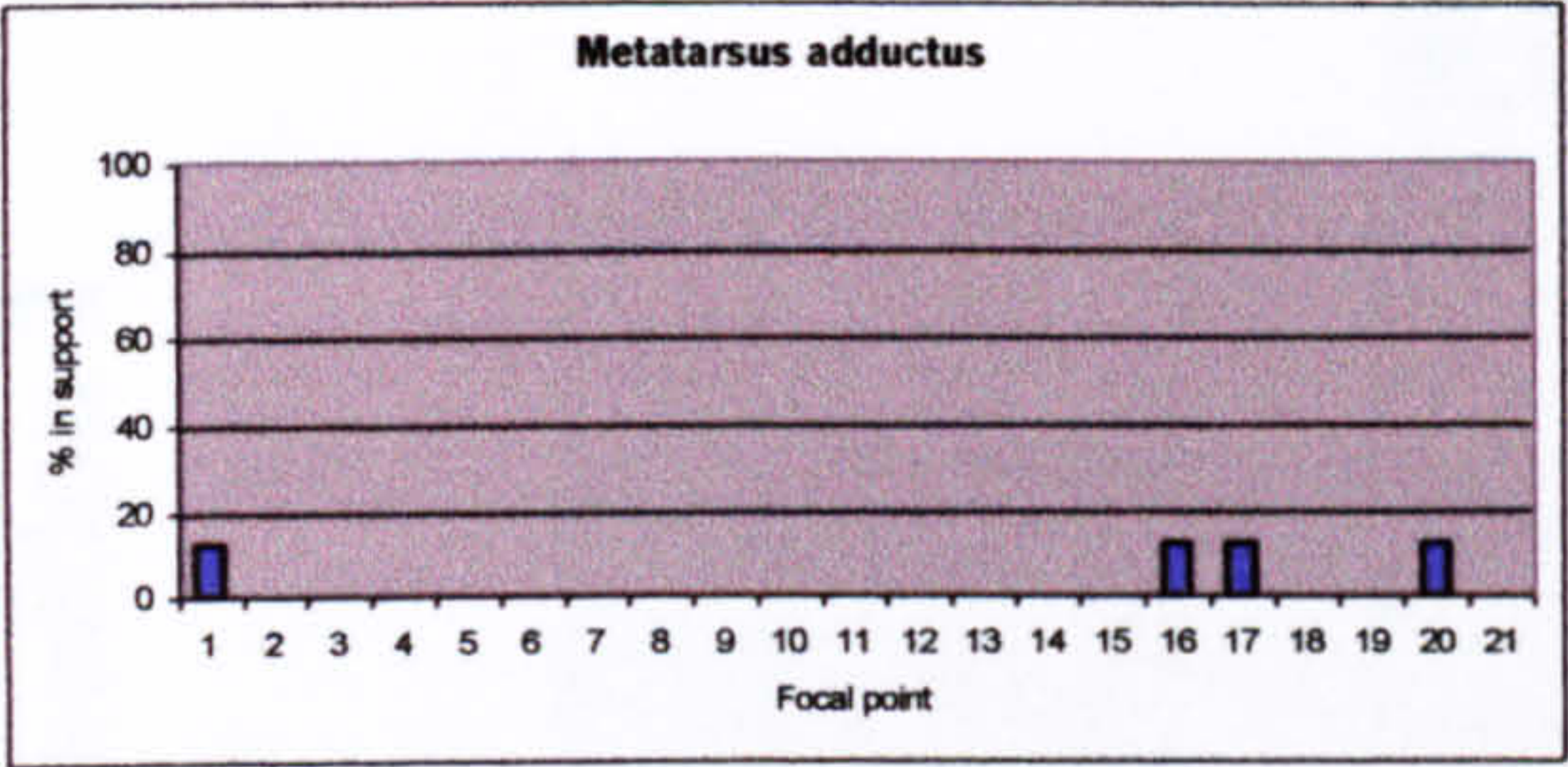
GRAPH 3 Hidden levels of focal point consensus in Delphi round 2, section 1



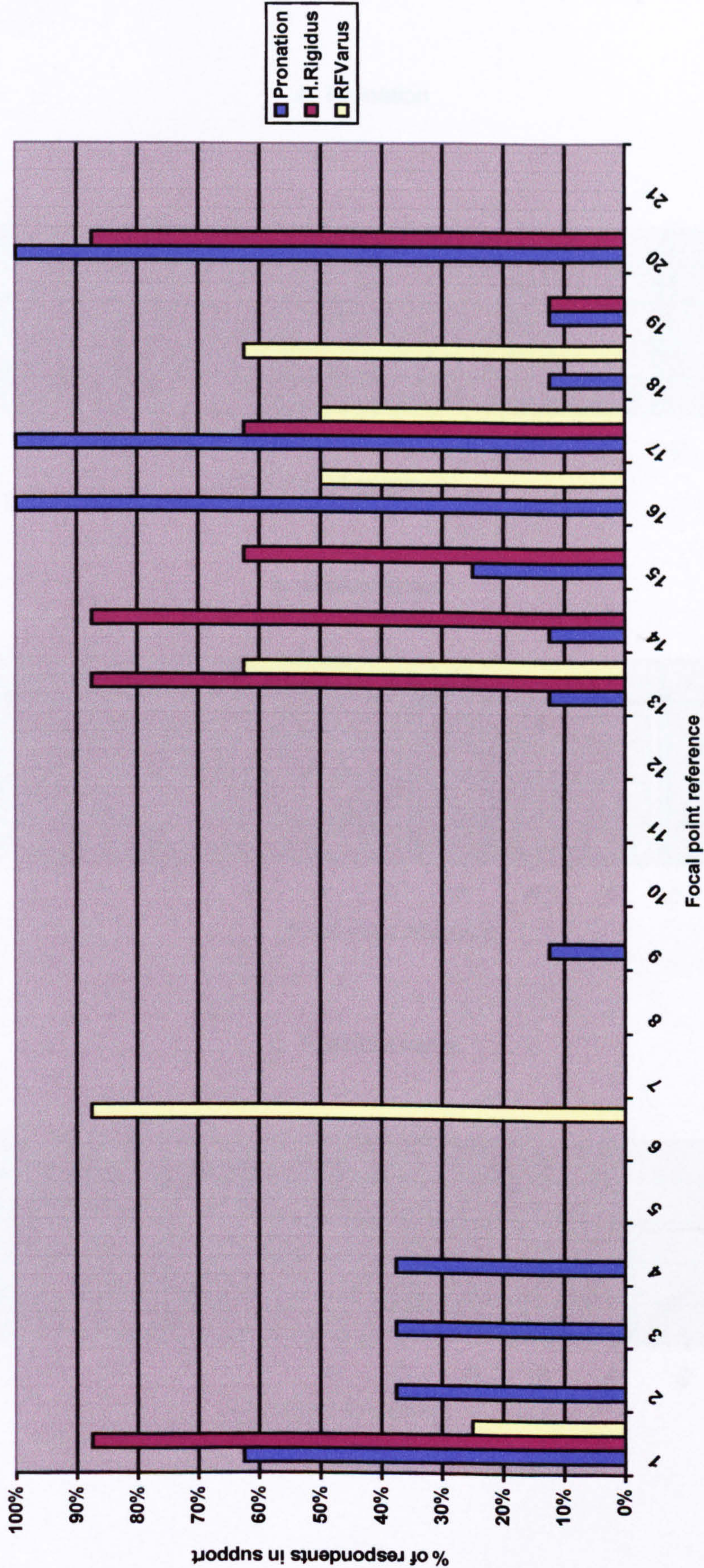
GRAPH 3 - contd.



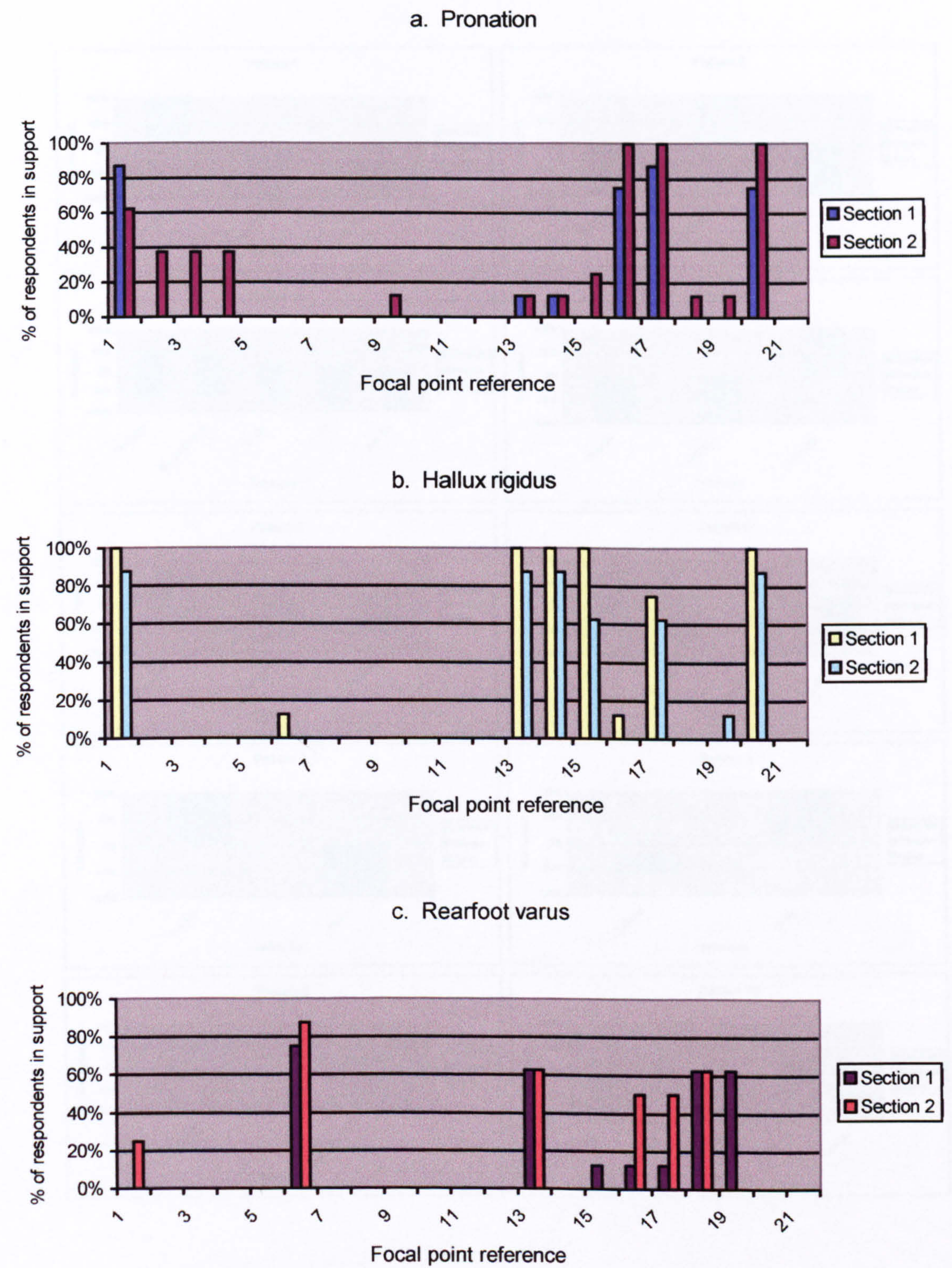
GRAPH 3 – contd.



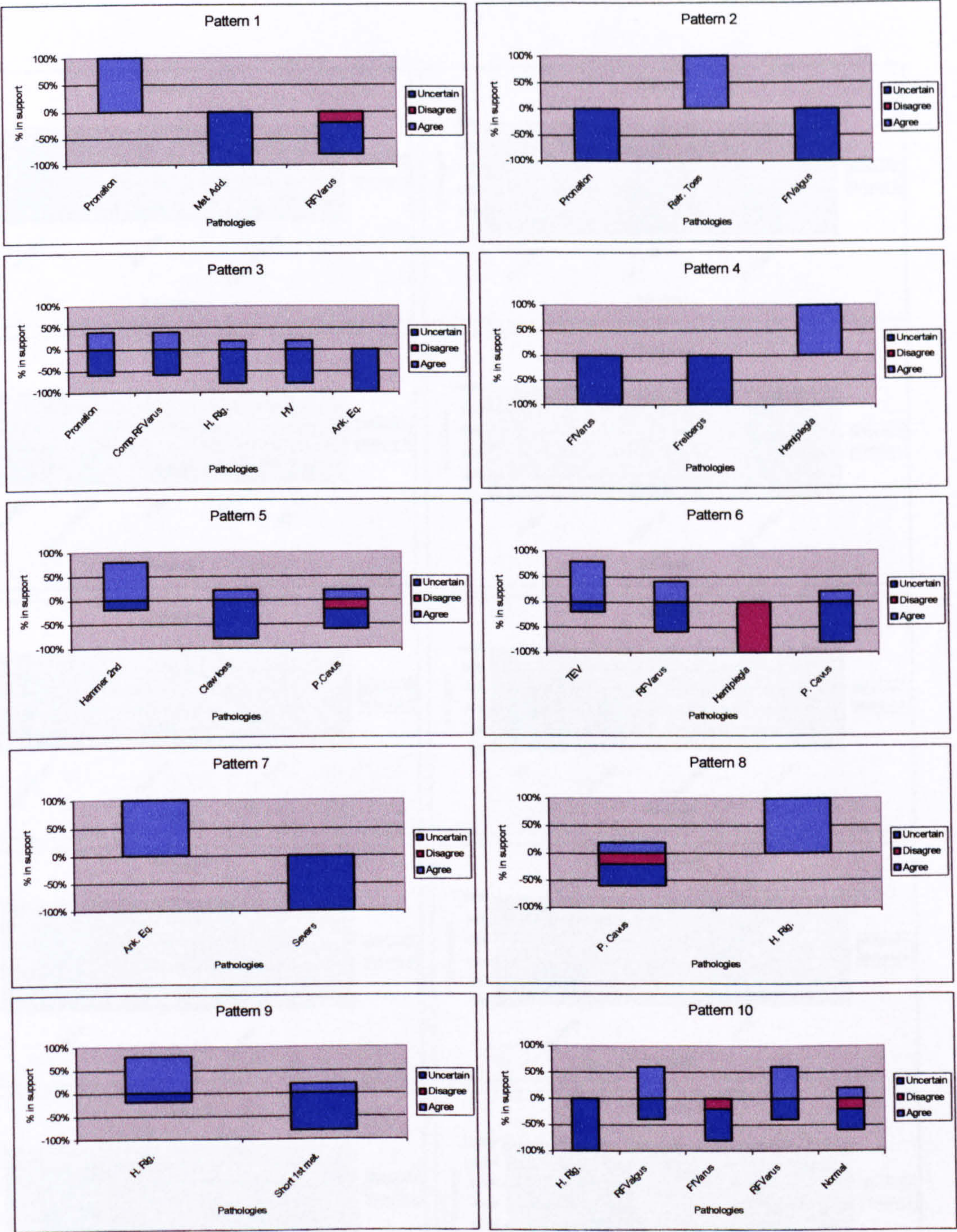
GRAPH 4 Hidden levels of focal point consensus in Delphi round 2, section 2



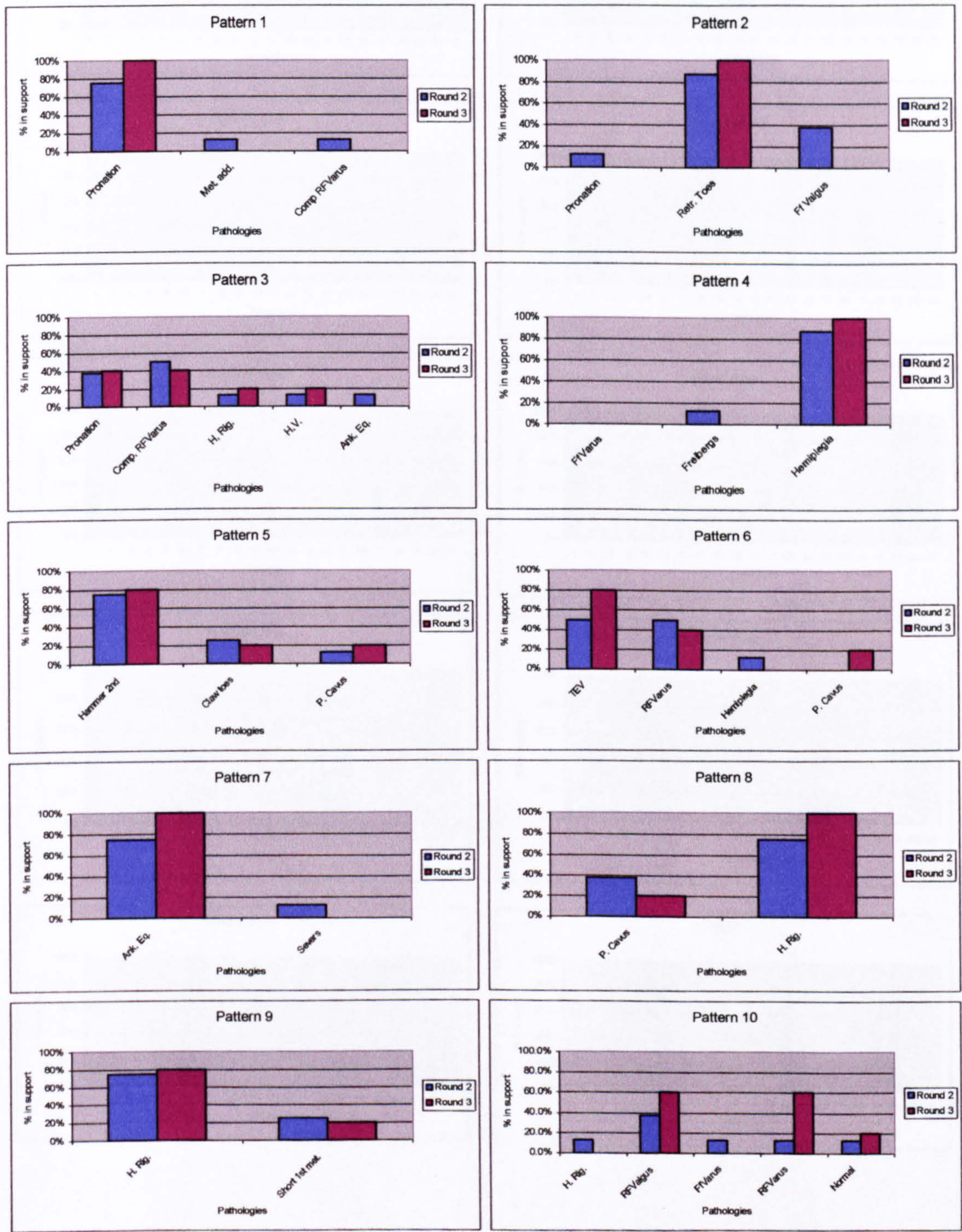
GRAPH 5 Comparison of focal point agreements between pathologies common to sections 1 and 2, Delphi round 2



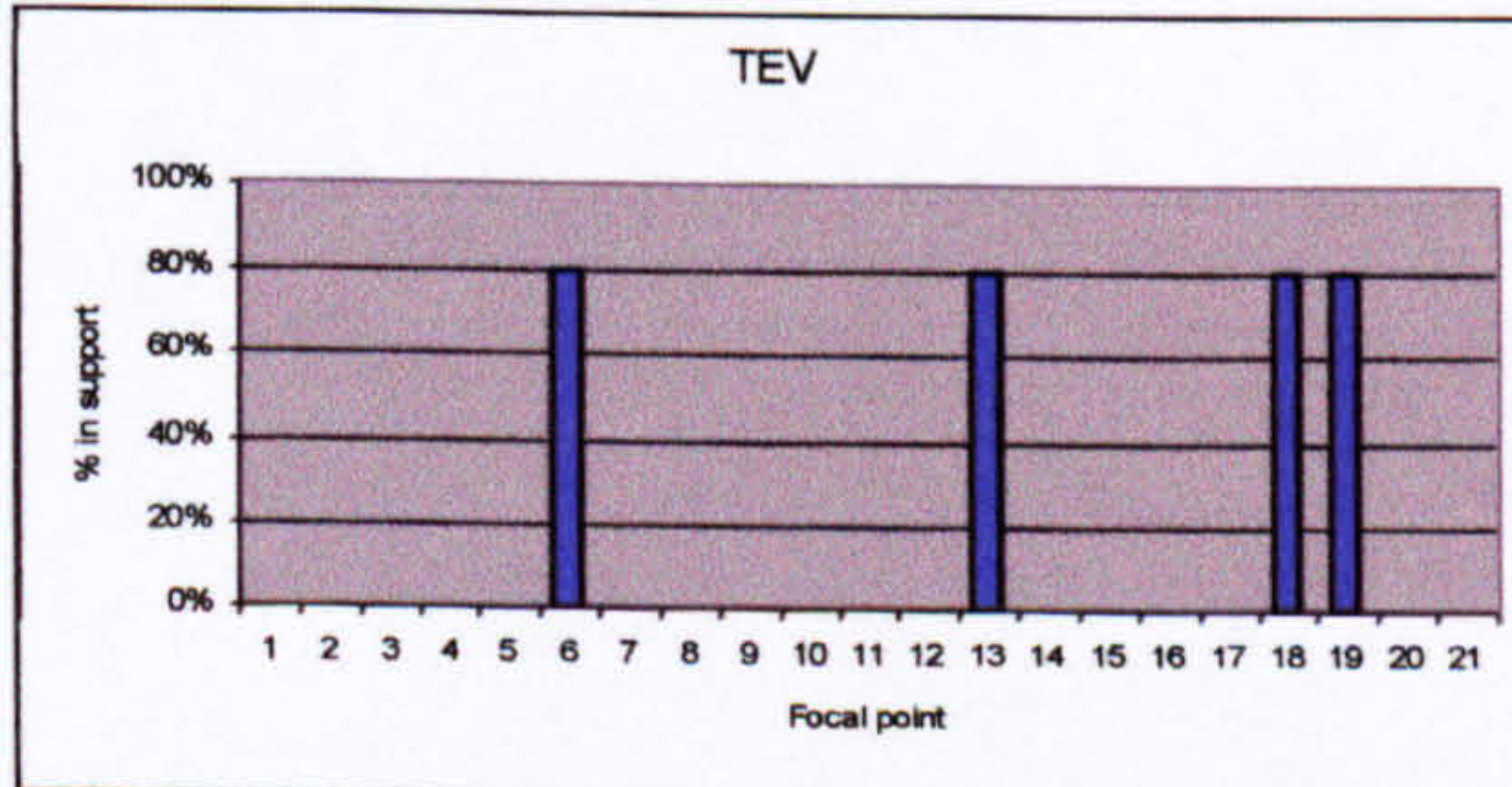
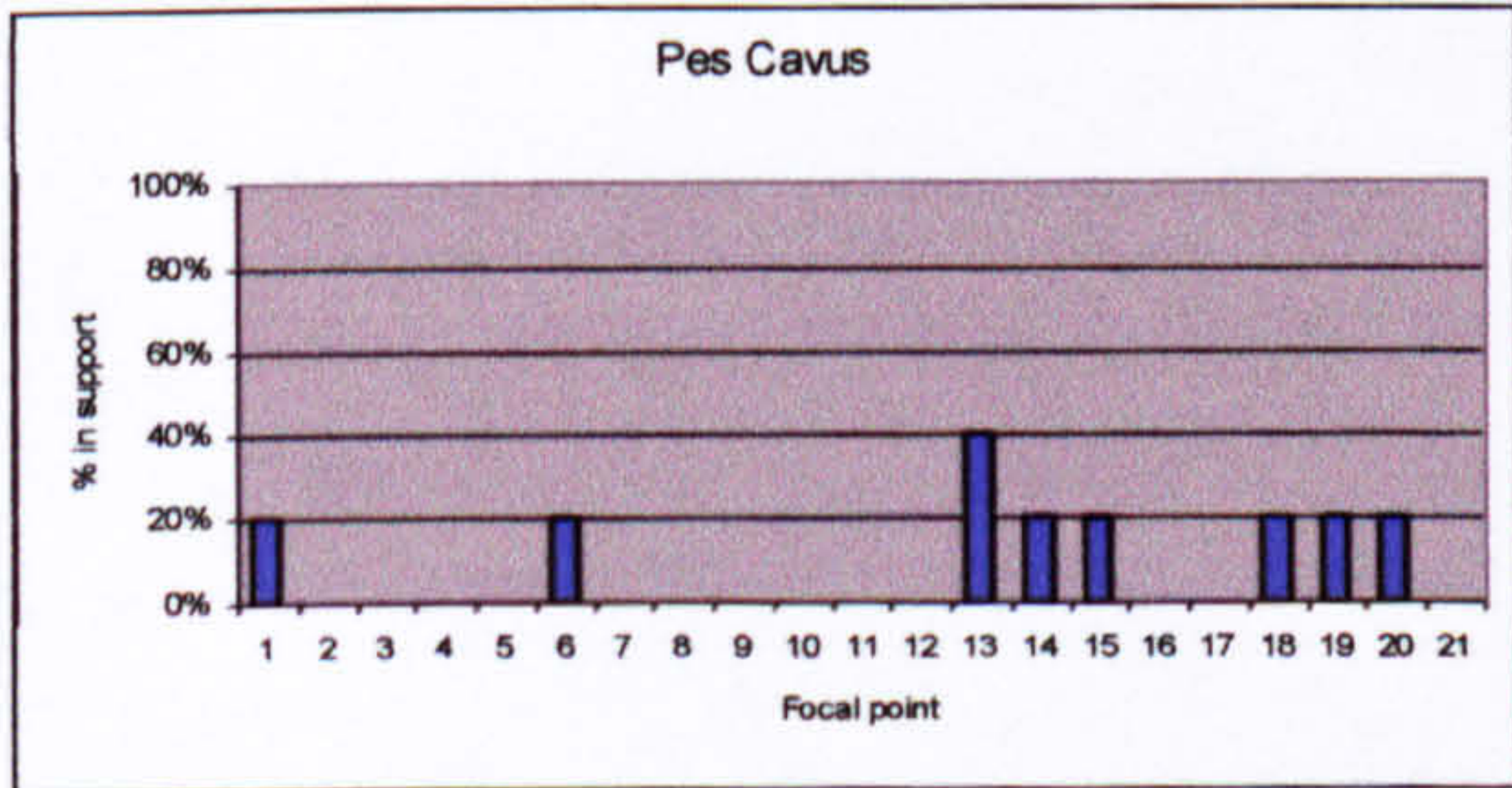
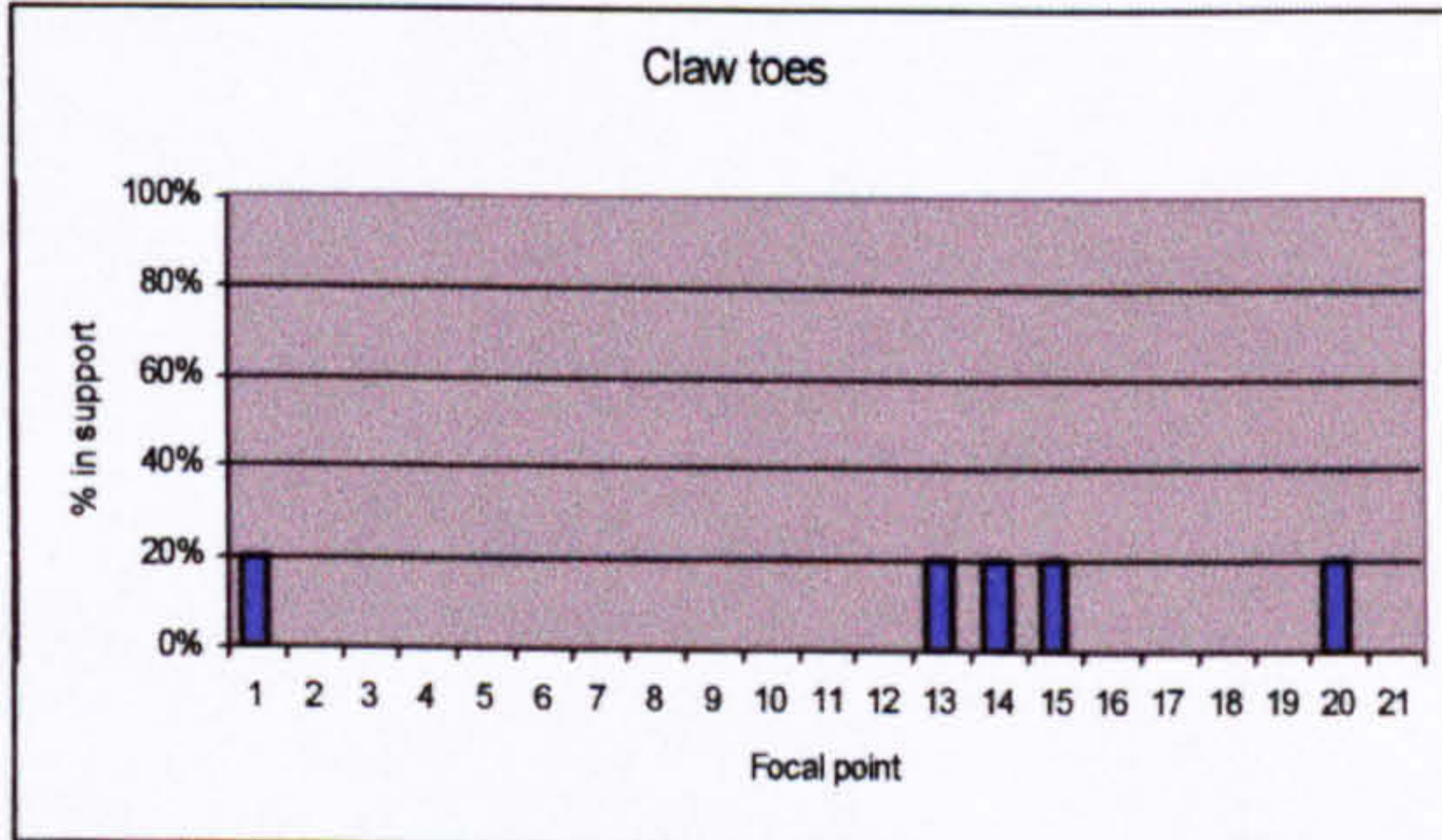
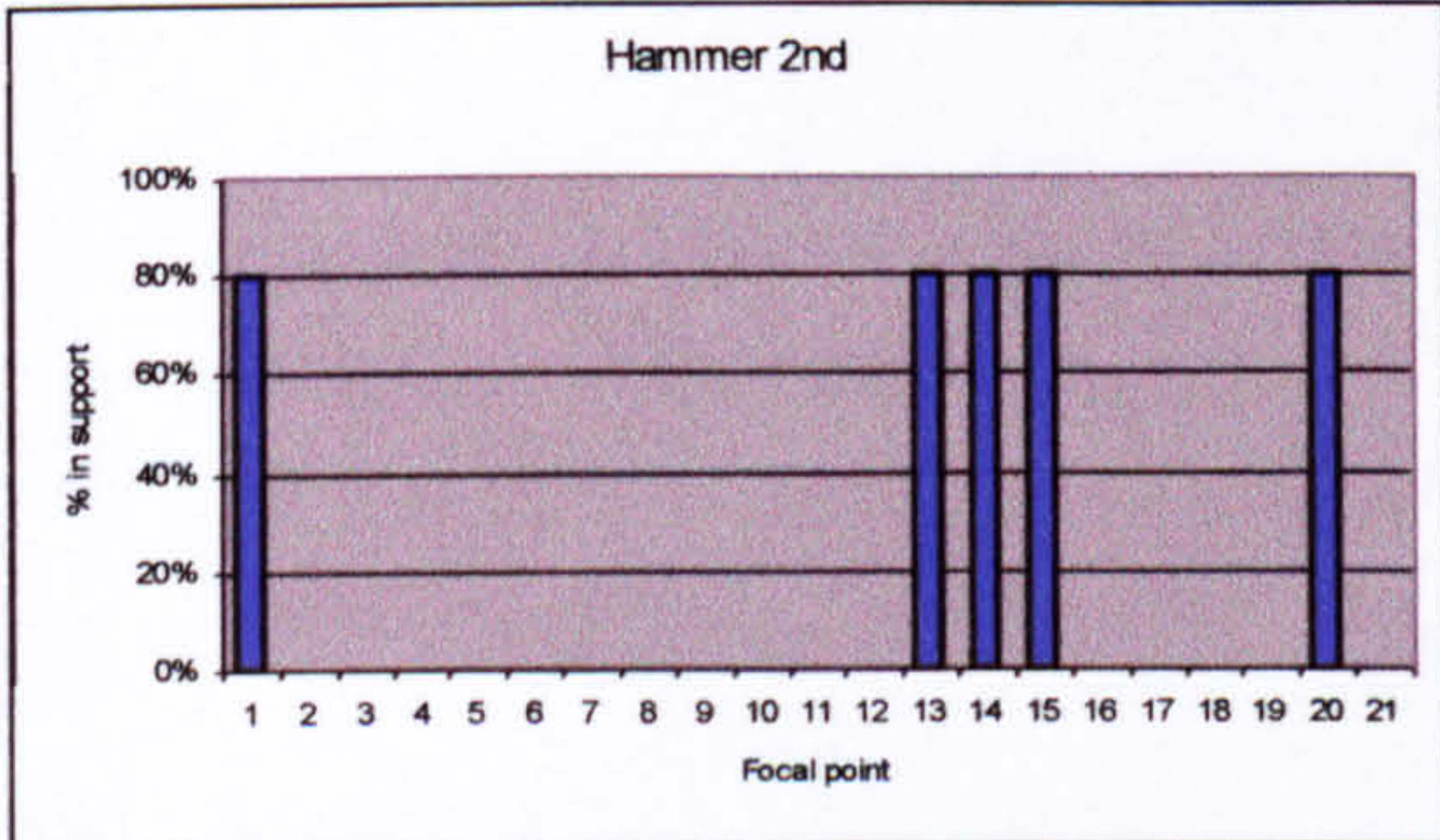
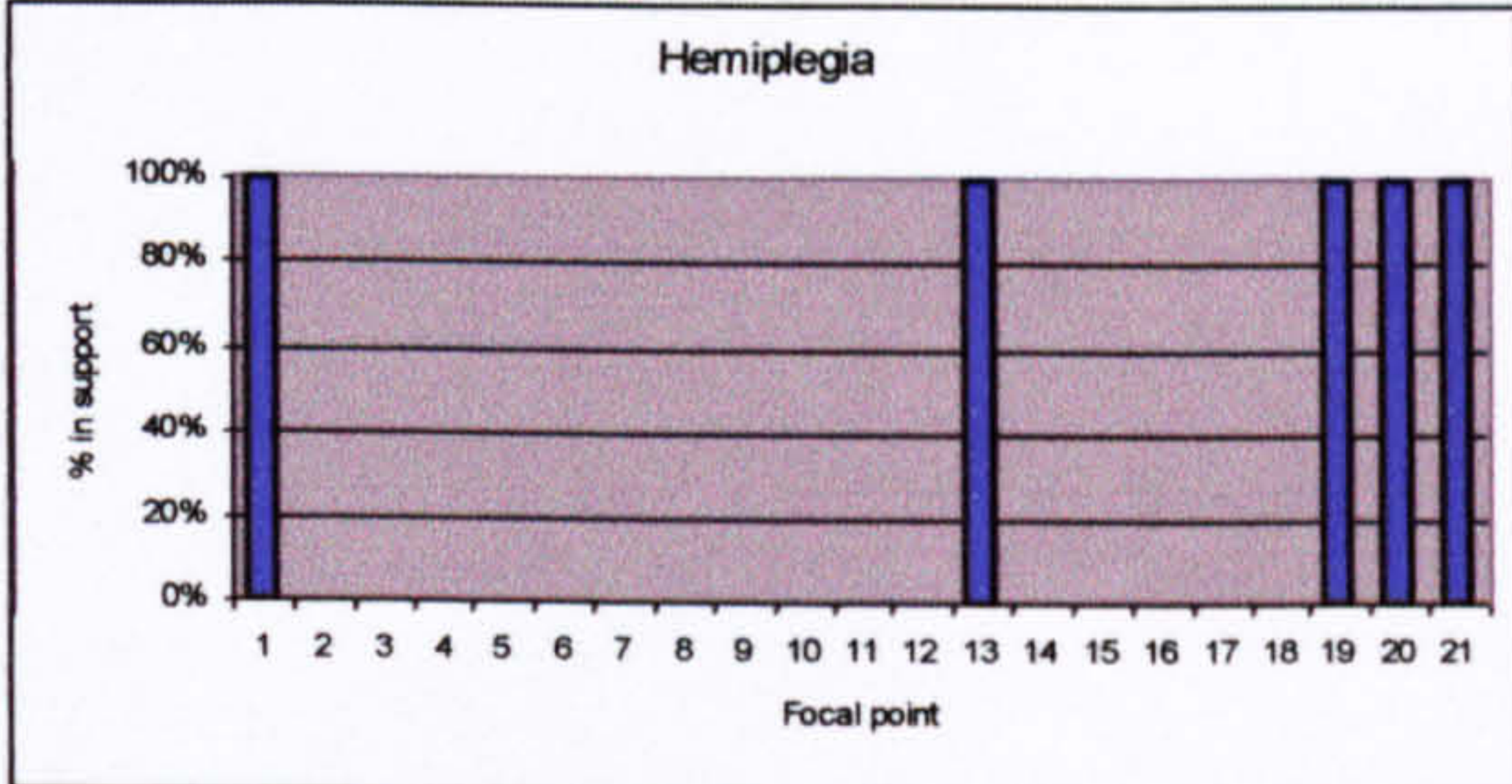
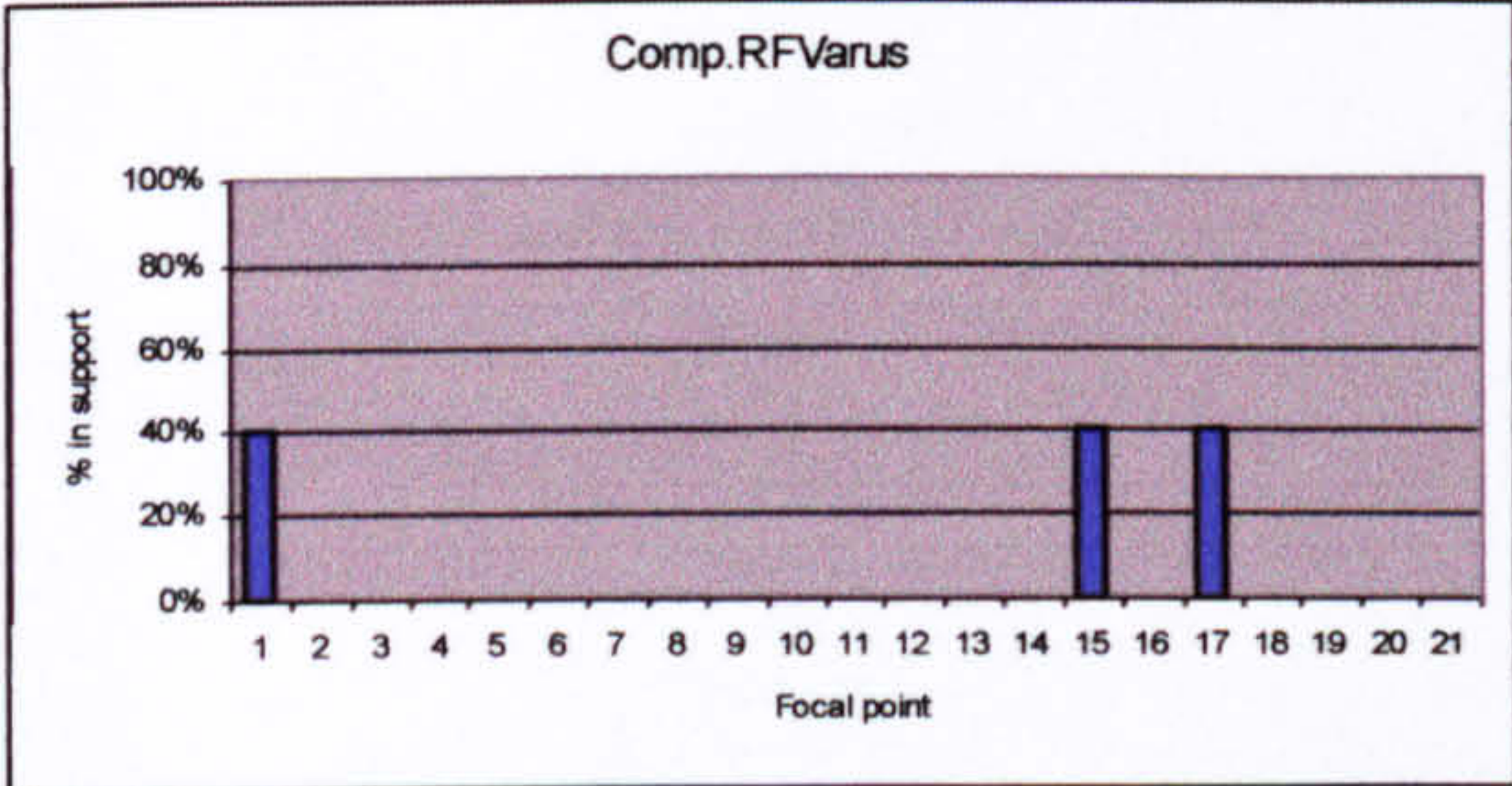
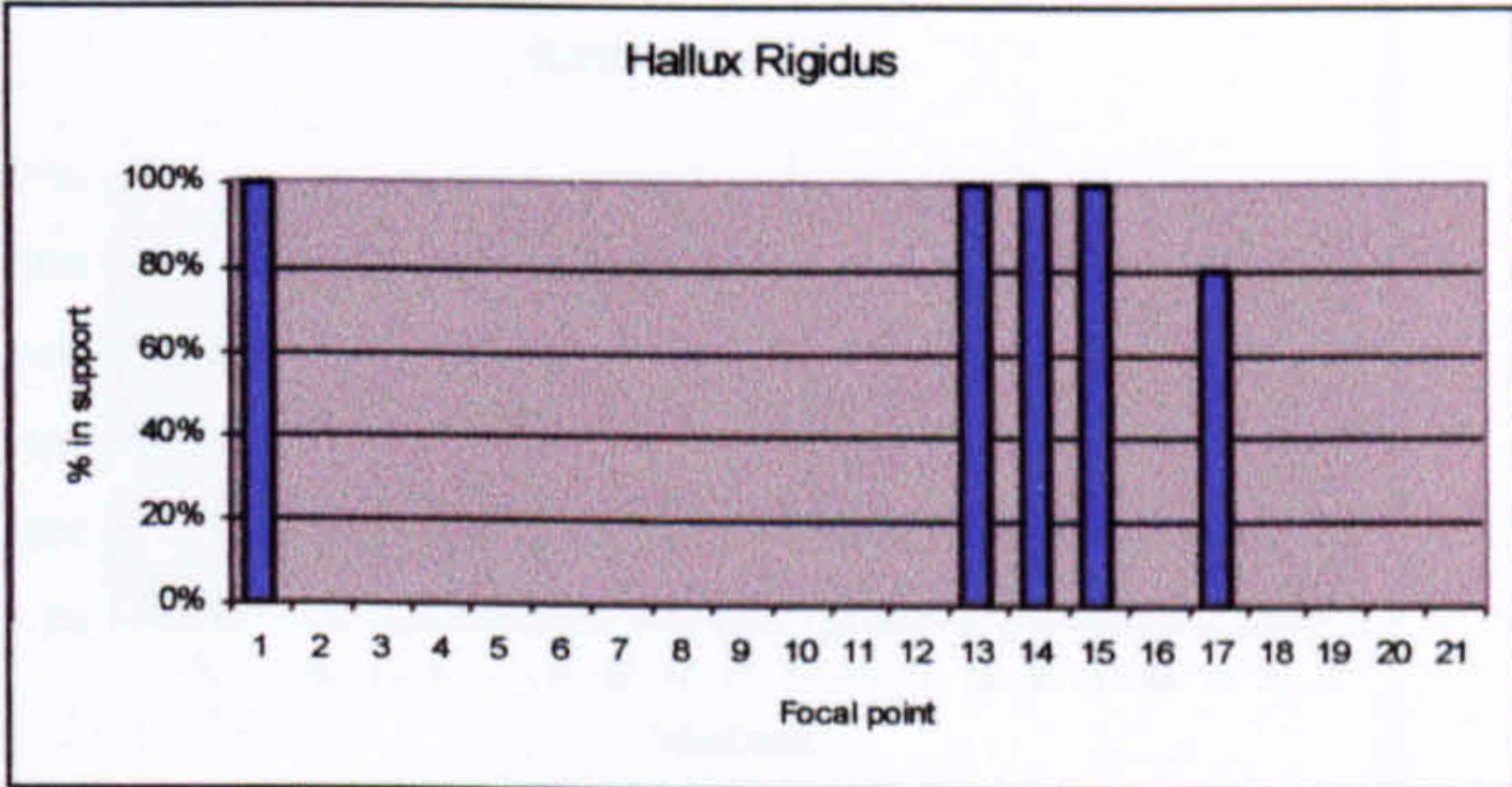
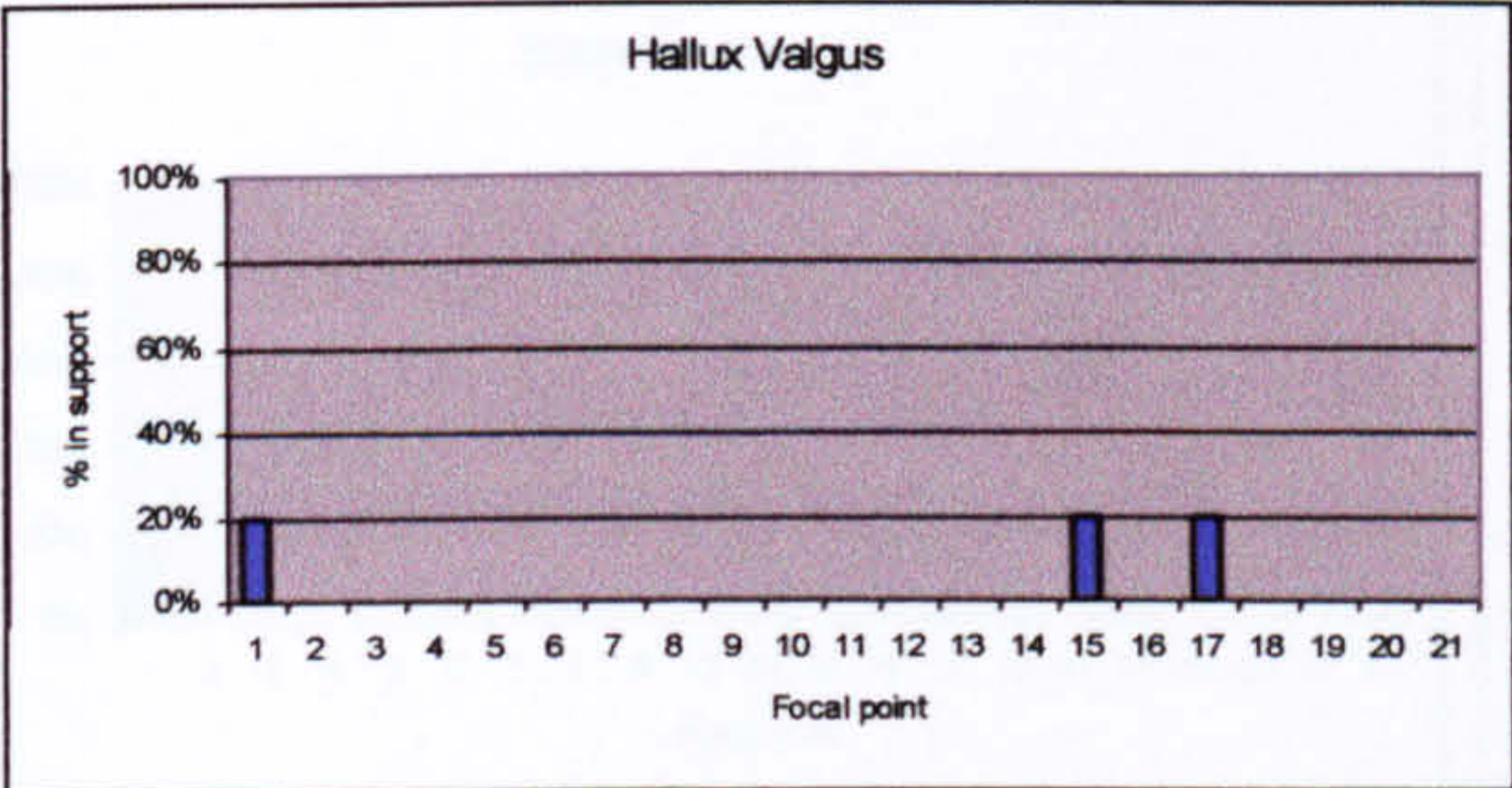
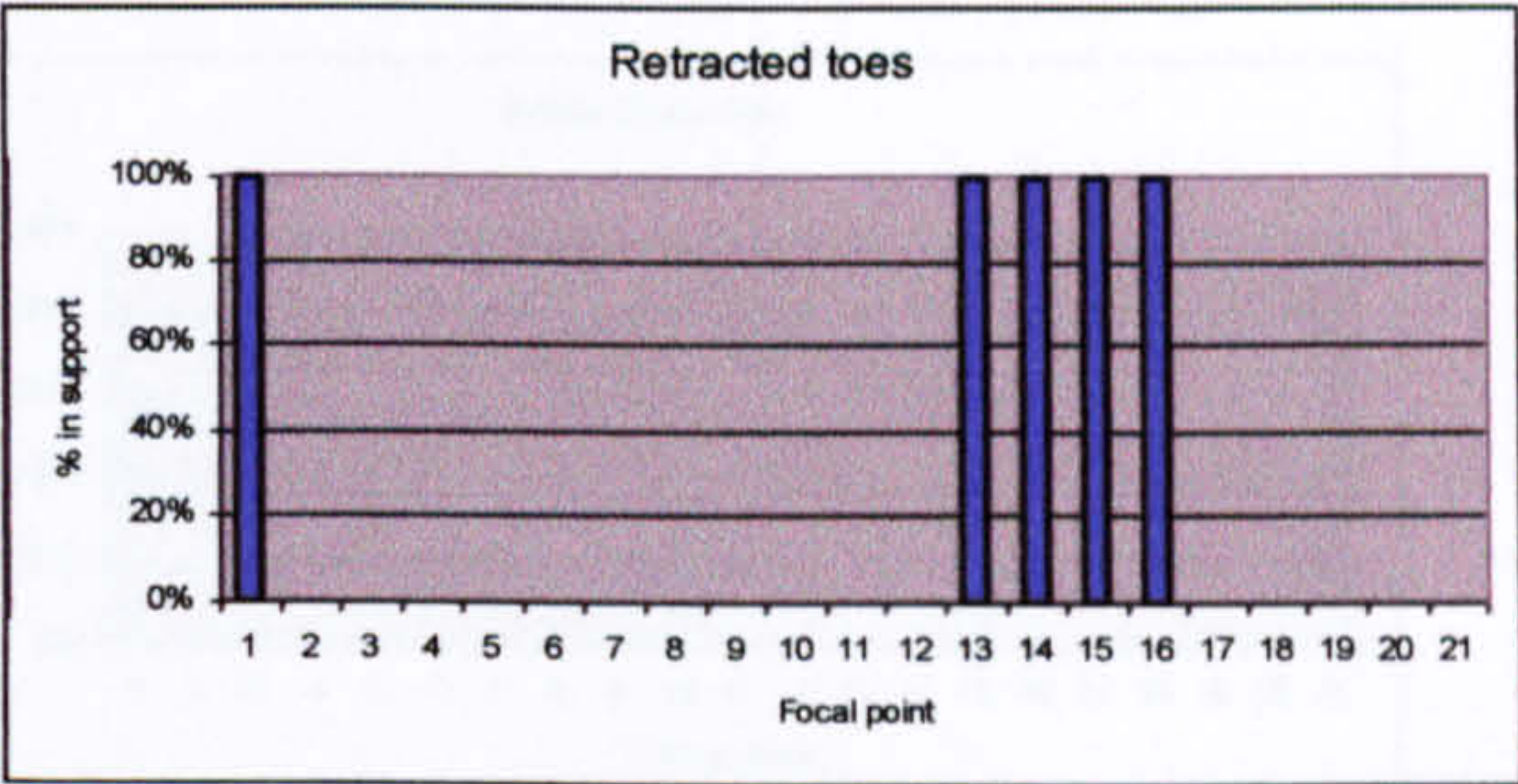
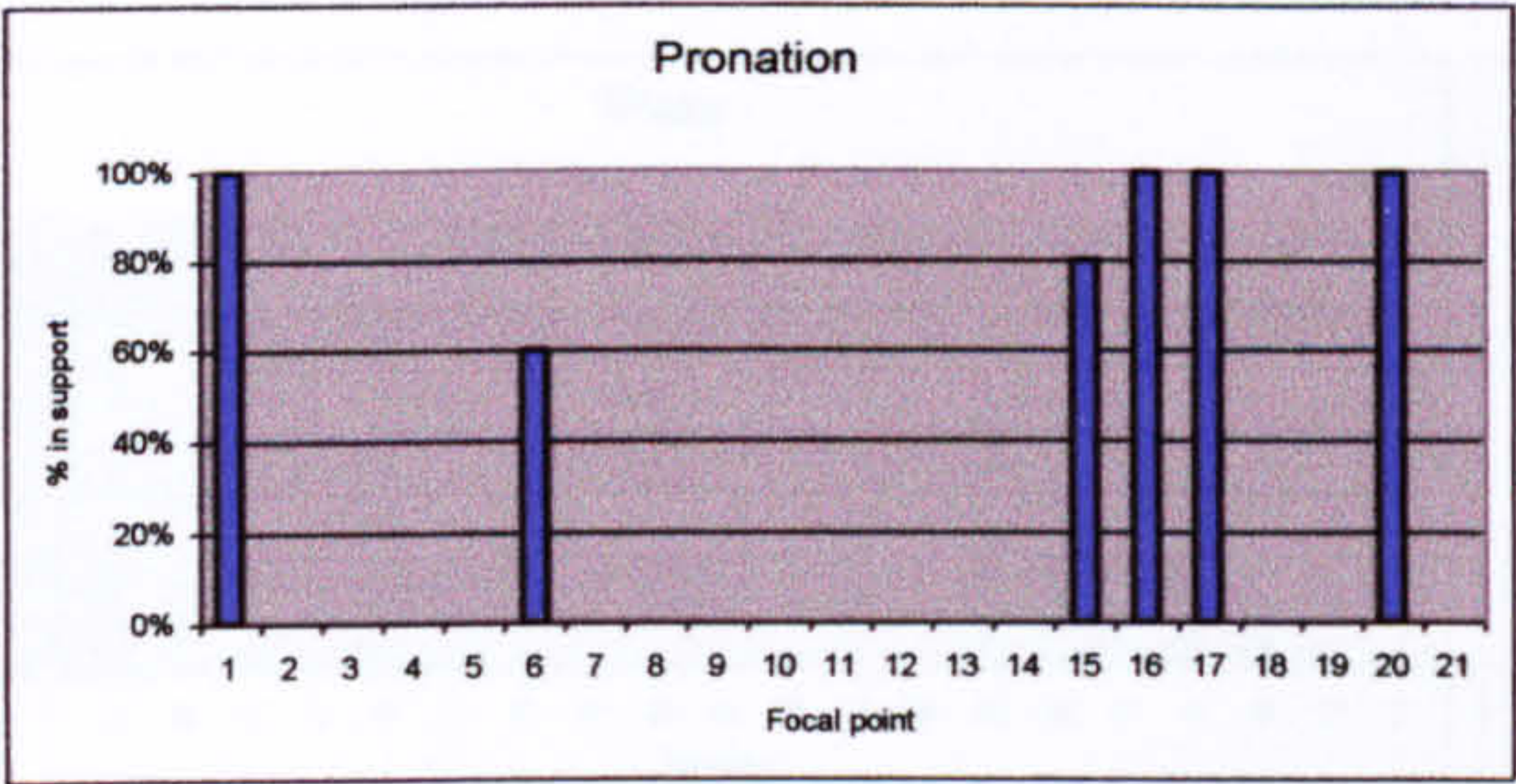
GRAPH 6 Delphi round 3, section 1 face consensus achieved



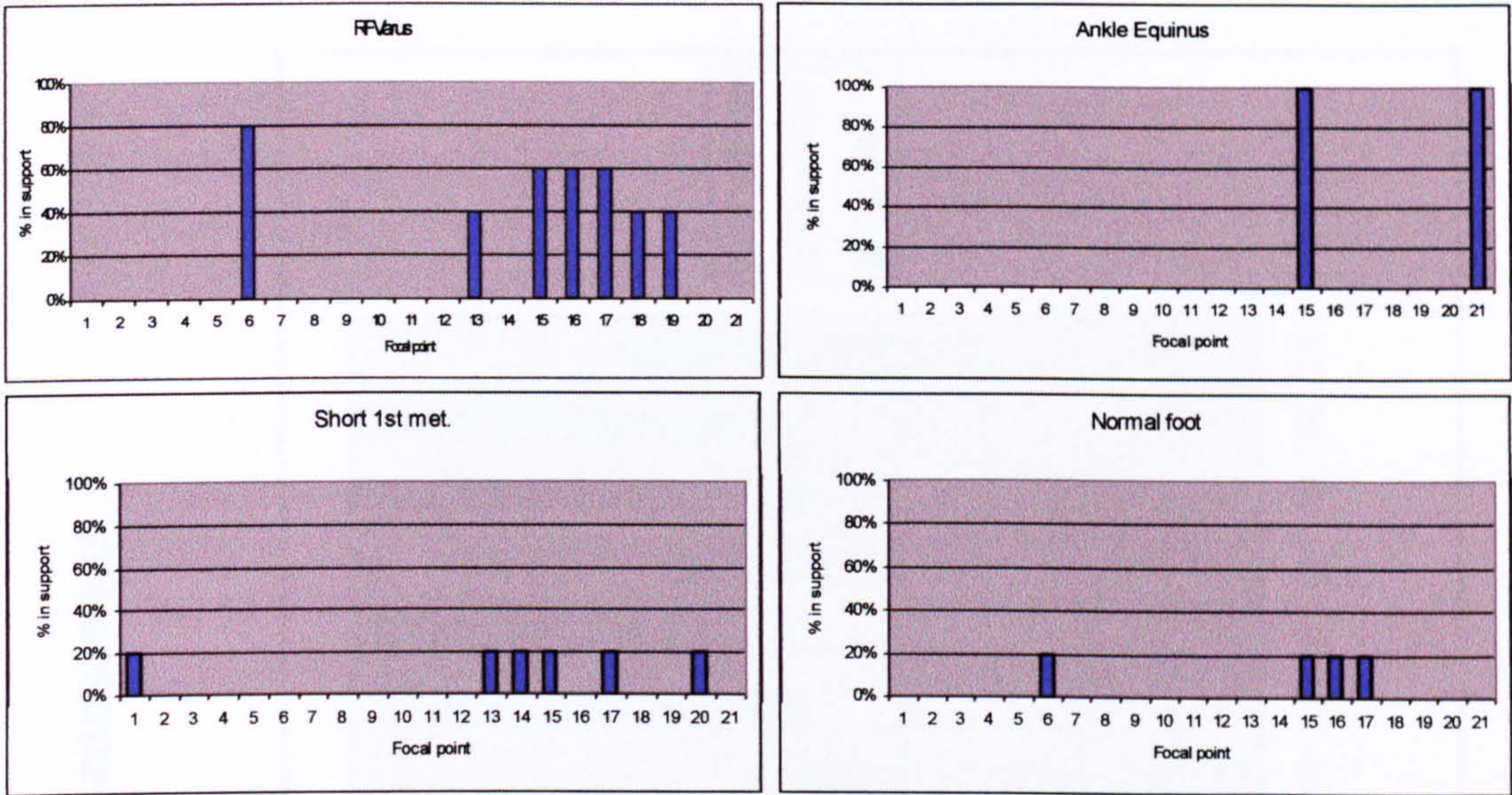
GRAPH 7 Delphi round 3, section 1 – comparison of face level consensus with round 2, section 1



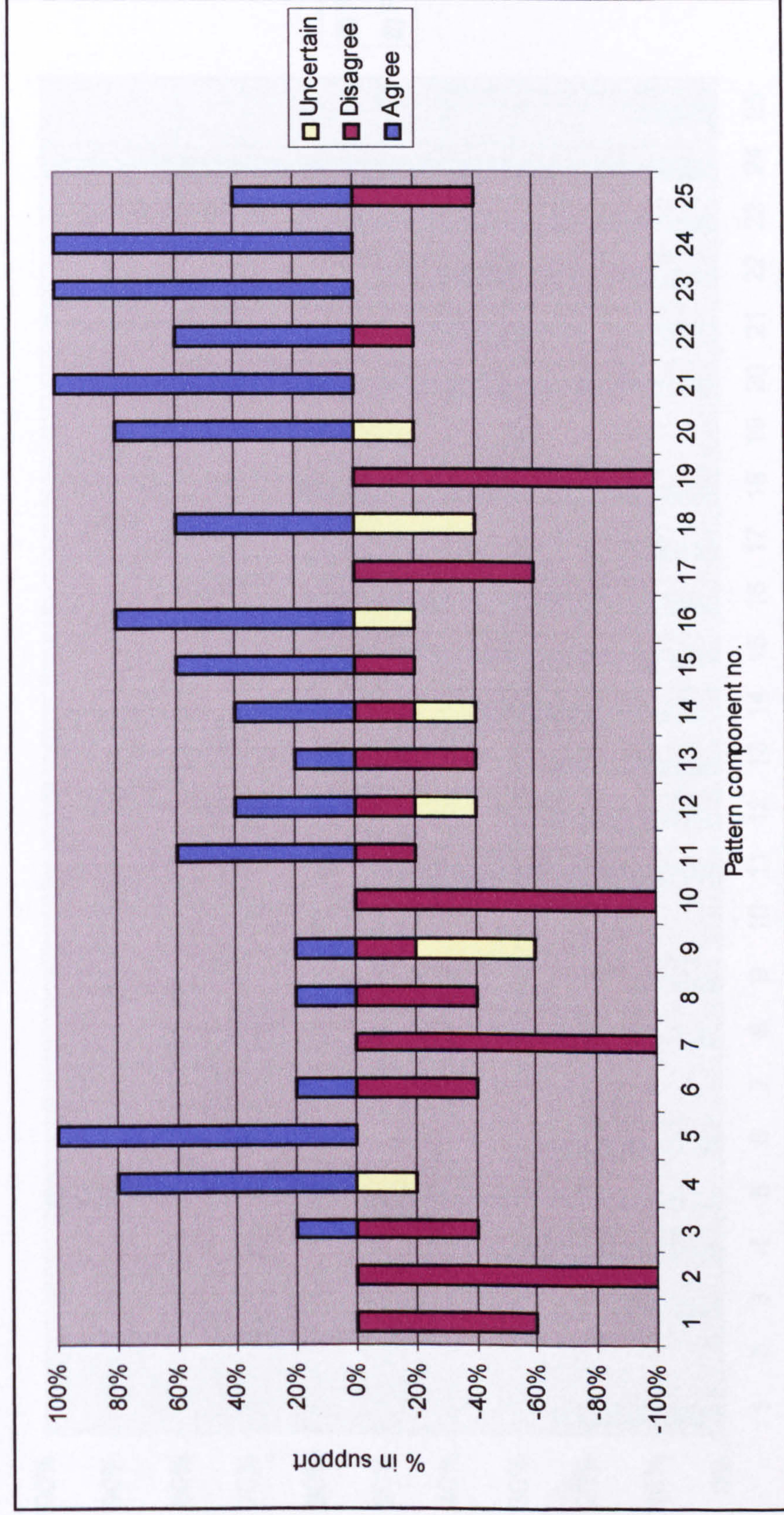
GRAPH 8 Delphi round 3, section 1, focal point consensus



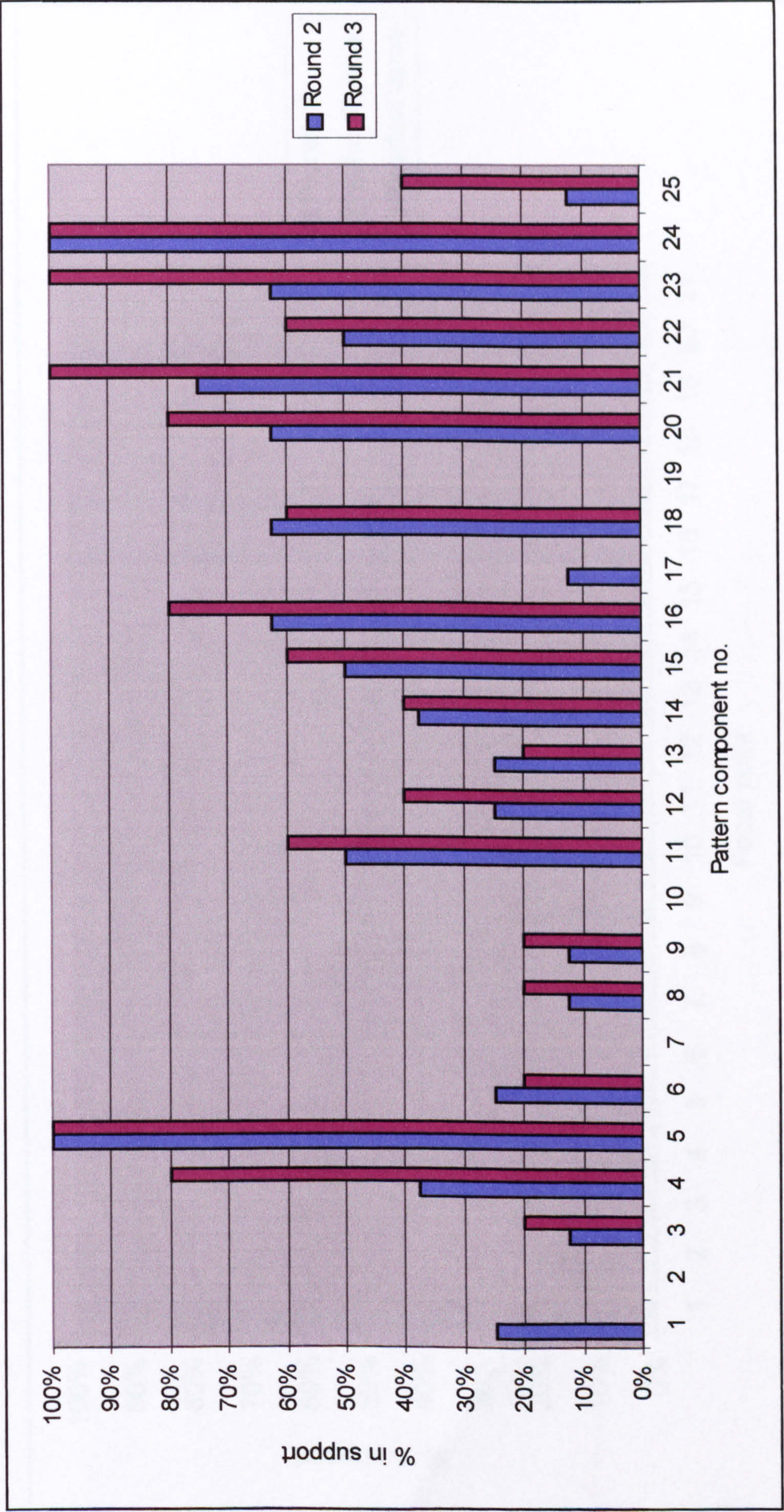
GRAPH 8 – contd.



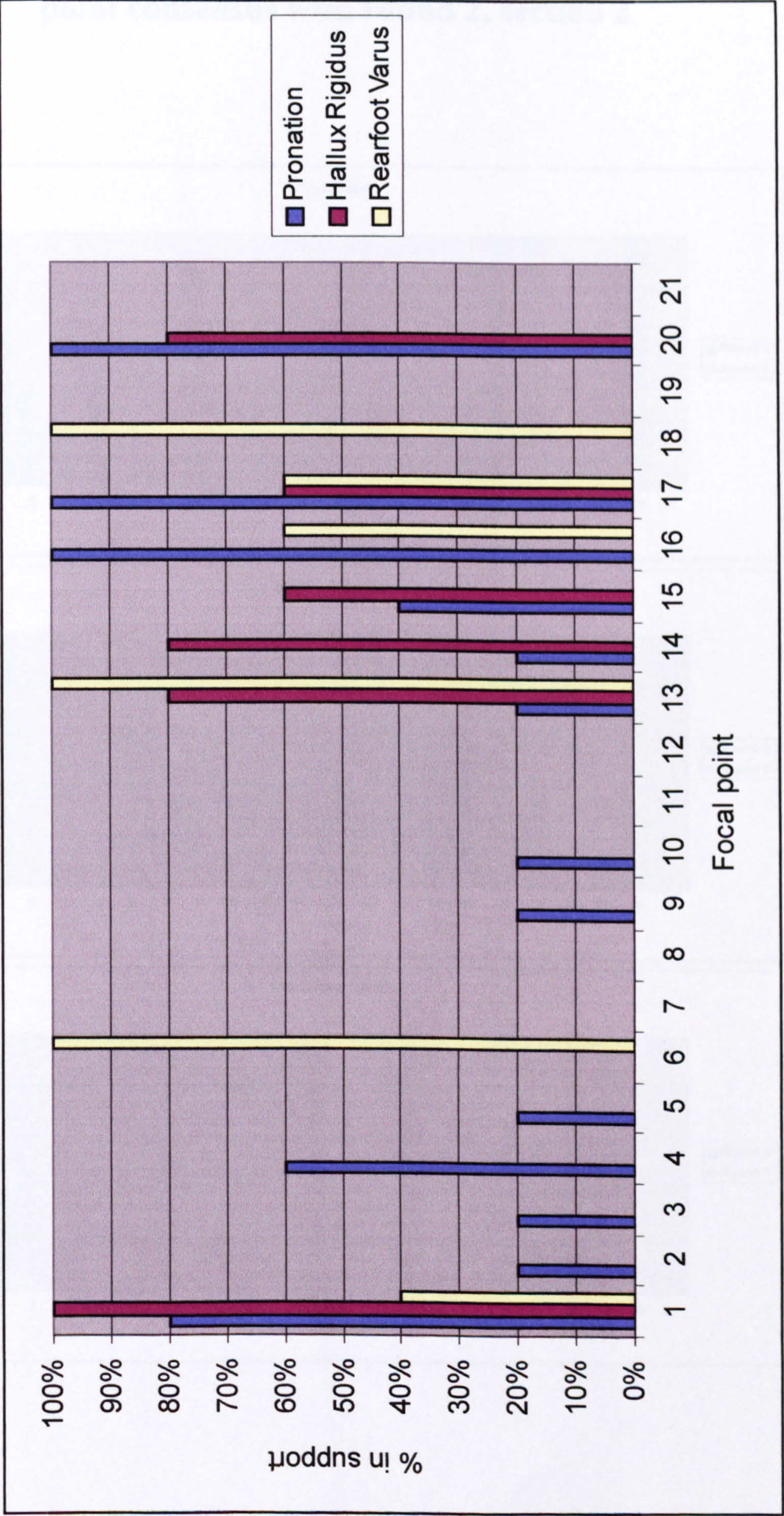
GRAPH 9 Delphi round 3, section 2 - face consensus



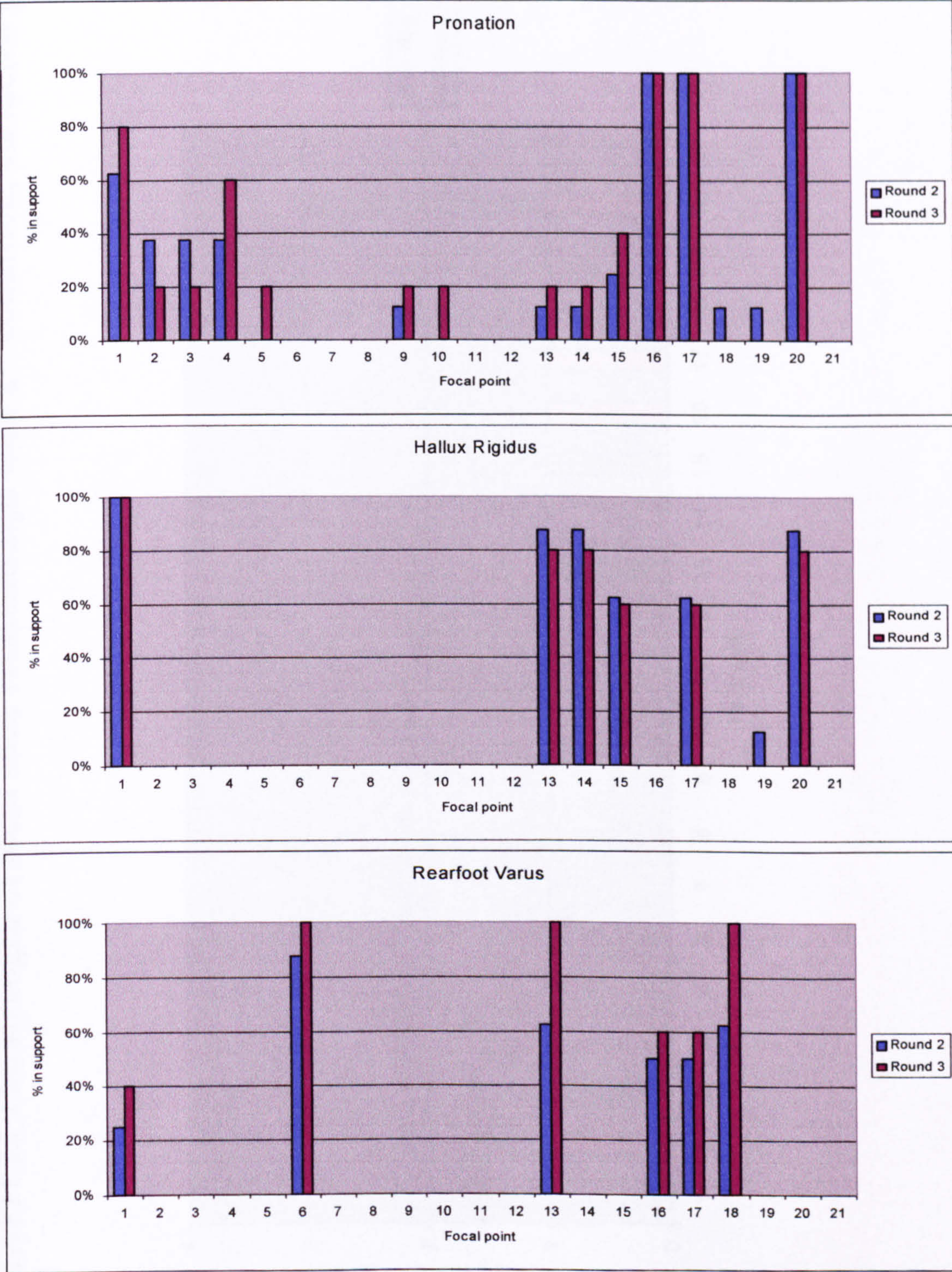
GRAPH 10 Delphi round 3, section 2 – comparison of face level consensus with round 2, section 2



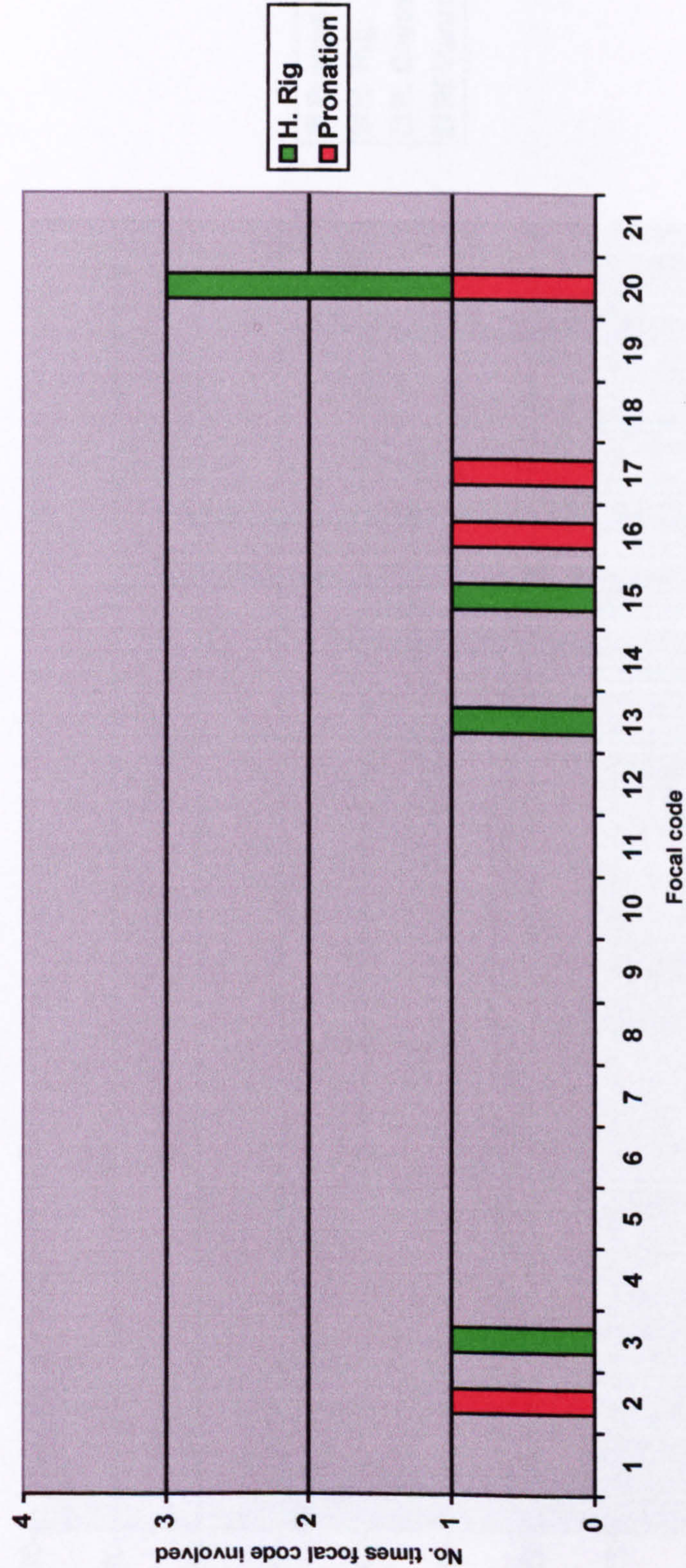
GRAPH 11 Delphi round 3, section 2 – focal point consensus



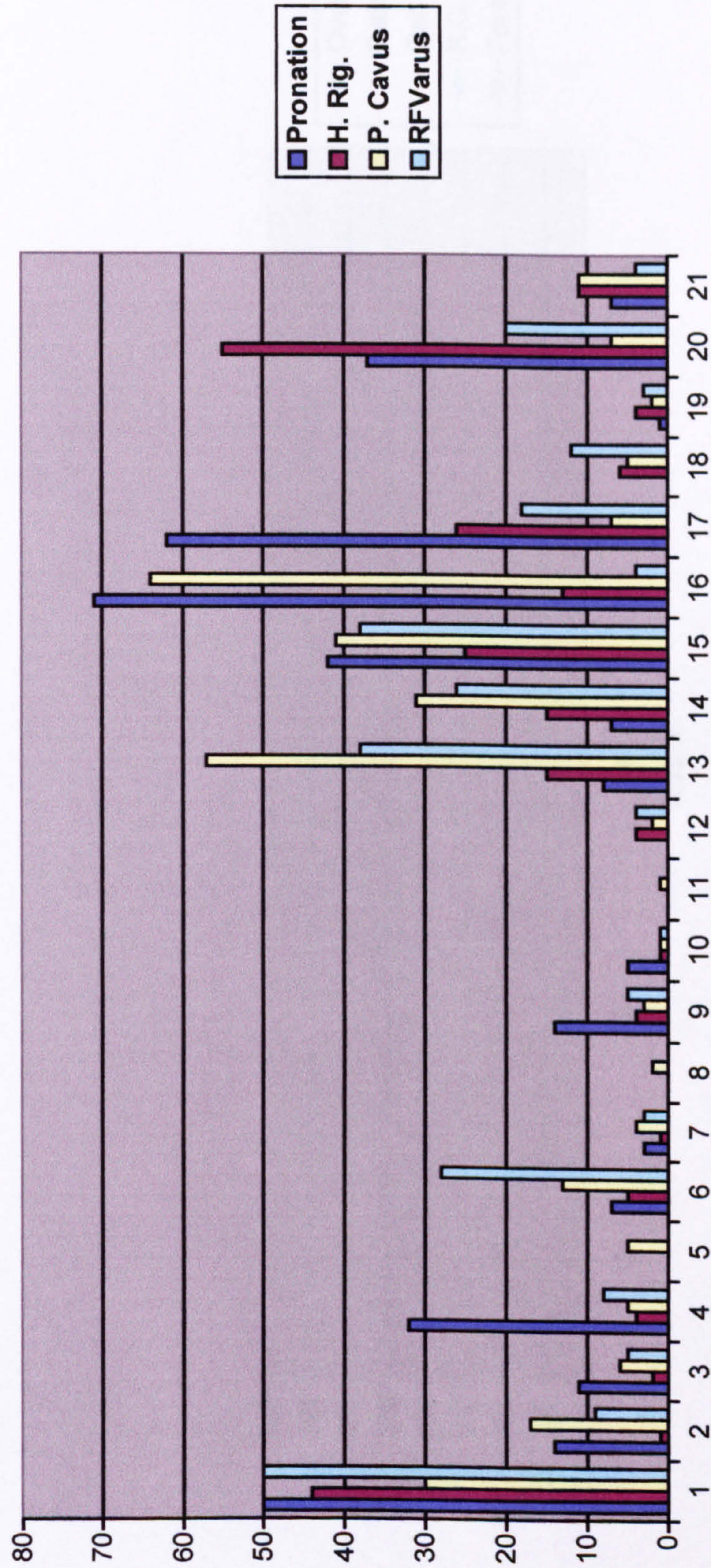
GRAPH 12 Delphi round 3, section 2 – comparison of focal point consensus with round 2, section 2



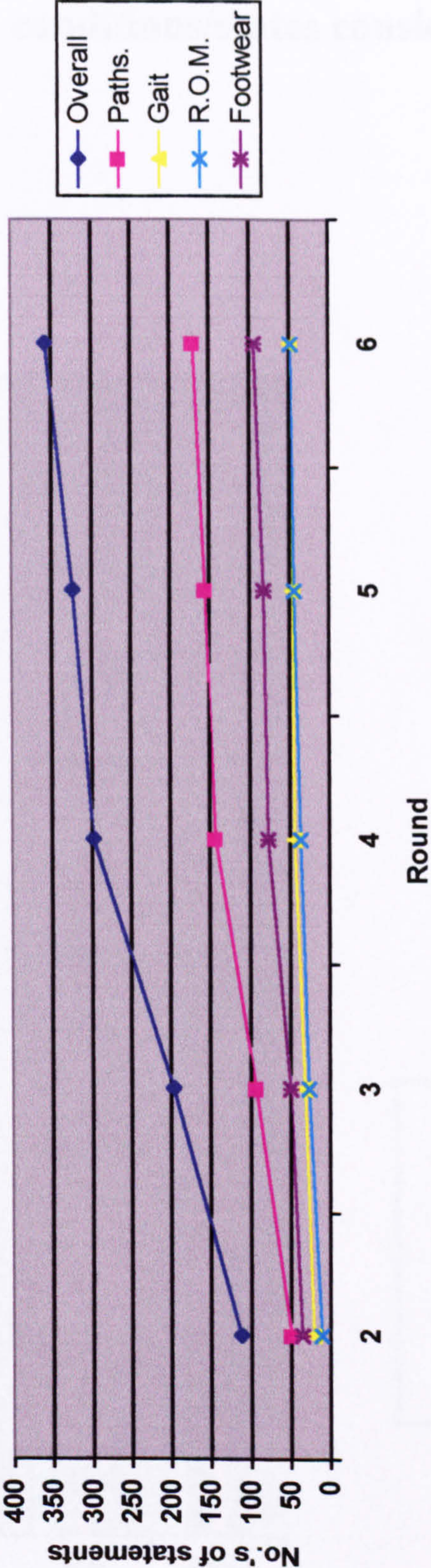
GRAPH 13 The strength of focal code relationships with 2nd condition, adducted gait



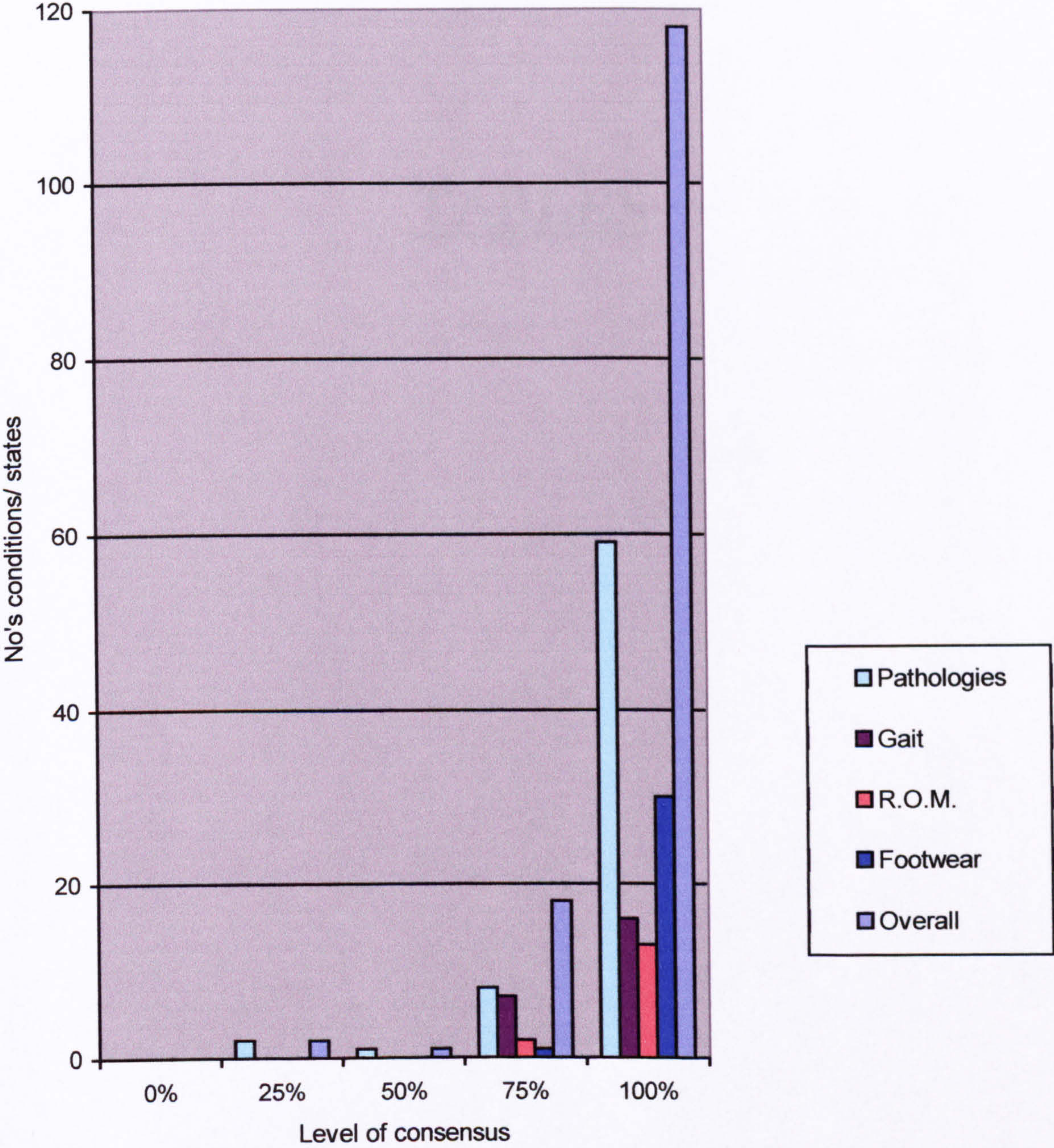
GRAPH 14 The strength of focal code relationships of the four main pathologies



GRAPH 15 Statements with 100% and 0% consensus, pre-validation Delphi rounds 2 - 6



GRAPH 16 Highest levels of consensus reached in pre-validation Delphi round 6 for conditions/states considered



TABLES

**TABLE 1 Pathologies for which wear patterns were given by
Delphi round 1 participants**

Pathology	No. responses	Pathology	No. responses
Calcaneo- valgus/pronated foot	12	Charcot-Marie-Tooth disease	1
Hallux rigidus	5	Claw toes	1
Rearfoot varus	4	Foot drop	1
Hallux valgus	3	Forefoot varus	1
Parkinsonism	3	Freibergs infraction	1
Ankle equinus	2	Genu valgum	1
Forefoot valgus	2	Genu varum	1
Hemiplegia	2	Hammer 2nd toe	1
In-toed gait	2	High stepping gait	1
Pes cavus	2	H'mobile 1st and 5th mets.	1
Retracted toes	2	Metatarsus adductus	1
Severs disease	2	Out toed gait	1
Talipes equino varus	2	Rheumatoid arthritis	1
Ataxic gait	1	Short 1st metatarsal	1
Charcot joint	1		

TABLE 2 Number of responses for each pathology showing wear in specific areas of the outsole

	No. of responses showing wear in each area of the outsole (expressed as proportion of total patterns received for each pathology)														
Pathology	Toe areas					Metatarsal head areas					Heel areas				
	Apex of 1st	Apex of 2,3,4	1st	5th	1	2/3	4	5	Ant.	Ant. med.	Ant. lateral	Post. med	Post. Lat	Central	Post.
Calc.valg./Pron.	6/12		8/12		8/12	5/12	3/12	3/12	1/12	5/12		5/12			3/12
H.Rig.	4/12			2/5	1/5	3/5	3/5	4/5					5/5		
RF varus			3/4	2/4	4/4	3/4	1/4	2/4			1/4		4/4		
H.Valgus	1/3		1/3	1/3	2/3	3/3	2/3	2/3		1/3		1/3	2/3		
Parkinsons	2/3	1/3	2/3	2/3	3/3	3/3	3/3	3/3	1/3	1/3	1/3	1/3	1/3	1/3	2/3
Retracted toes					2/2	2/2	2/2	2/2					1/2		
Ankle equinus		2/2				2/2		1/2					1/2		
Forefoot. valgus	1/2		1/2	1/2	1/2	1/2	1/2	1/2					2/2		
Intoeed gait		2/2		1/2		1/2	1/2	2/2			1/2		2/2		
Talipes Eq. Varus				2/2		1/2		2/2			2/2		1/2		
Severs disease	1/2	2/2	1/2			2/2	1/2	1/2							
Hemiplegia		2/2		1/2		1/2	1/2	2/2					1/2		
Pes cavus	1/2	2/2			1/2	1/2	1/2	2/2			1/2		2/2		

TABLE 3 Patterns for which additional pathologies were suggested in Delphi round 2

Pattern reference	Additional suggested causative conditions
1	Partially compensated rearfoot varus
3	Ankle equinus Hallux rigidus Hallux abductor valgus
5	Pes cavus
6	Hemiplegia
10	Forefoot varus Rearfoot varus Normal foot

TABLE 4 Anatomical references for focal codes – the positions from which outsole wear would spread

Focal code no.	Anatomical area represented by focal code
1	Posterior lateral heel
2	Posterior heel
3	Posterior medial heel
4	Medial heel
5	Central heel
6	Lateral heel
7	Anterior lateral heel
8	Anterior central heel
9	Anterior medial heel
10	Anterior inner longitudinal arch
11	Centre of foot
12	Base of 5th metatarsal
13	5th metatarso-phalangeal joint
14	4th metatarso-phalangeal joint
15	2nd/3rd metatarso-phalangeal joint
16	1st metatarso-phalangeal joint
17	1st toe
18	Tip of 5th toe
19	Tip of 4th toe
20	Tip of 1st Toe
21	Tip of 2nd, 3rd and 4th Toes

TABLE 5 Areas covered by section 1 patterns, Delphi round 2

Pattern	Anatomical areas involved (with code)	Focal code combination
1	Posterior/lateral heel area (1.) 1st metatarso-phalangeal joint (16.) 1st toe (17.) Tip of 1st toe (20.)	1/16/17/20
2	Tip of 5th toe (18.) 1st toe (17.) 1st metatarso-phalangeal joint (16.) 2nd/3rd metatarso-phalangeal joint (15.) 4th metatarso-phalangeal joint (14.) 5th metatarso-phalangeal joint (13.) Posterior lateral heel area (1.)	1/13/14/15/16/17/18
3	1st toe (17.) 2nd/3rd metatarso-phalangeal joint (15.) Posterior lateral heel area (1.)	1/15/17
4	Tip of 2nd, and 3rd toes (21.) Tip of 1st toe (20.) Tip of 4th toe (19.) Tip of 5th toe (18.) 5th metatarso-phalangeal joint (13.) Posterior lateral heel area (1.)	1/13/18/19/20/21
5	Tip of 1st toe (20.) 2nd/3rd metatarso-phalangeal joint (15.) 5th metatarso-phalangeal joint (13.) Posterior lateral heel area (1.)	1/13/15/20
6	Tip of 4th toe (19.) Tip of 5th toe (18.) 5th metatarso-phalangeal joint (13.) Lateral heel area (6.)	6/13/18/19
7	Tip of 2nd, and 3rd toes (21.) 2nd/3rd metatarso-phalangeal joint (15.)	15/21
8	Tip of 1st toe (17.) 2nd/3rd metatarso-phalangeal joint (15.) 4th metatarso-phalangeal joint (14.) 5th metatarso-phalangeal joint (13.) Posterior-lateral heel area (1.)	1/13/14/15/17
9	Tip of 1st toe (20.) 1st toe (17.) 2nd/3rd metatarso-phalangeal joint (15.) 4th metatarso-phalangeal joint (14.) 5th metatarso-phalangeal joint (13.) Posterior-lateral heel area (1.)	1/13/14/15/17/20
10	1st toe (17.) 1st metatarso-phalangeal joint (16.) 2nd/3rd metatarso-phalangeal joint (15.) Lateral heel area (6.)	6/15/16/17

**TABLE 6 Areas covered by section 2 pattern components,
Delphi round 2**

Component no.	Focal code		Component no.	Focal code
1	20		14	1
2	17		15	1
3	16		16	20
4	16		17	19
5	16/17/20		18	13/14/15/17/20
6	13/14/15/16/17/18/ 19/20		19	16
7	13/14/15/16		20	13/14
8	15		21	1
9	9		22	16/17
10	7/8/9		23	13/18
11	4		24	6
12	3		25	1
13	2			

TABLE 7 Focal points marked by respondents in Delphi round 3

Respondent no.	No. points marked/ respondent	No. matching focal point positions	No. not matching focal point positions	Focal points matched
1	0	0	0	-
2	41	27	14	1/4/6/9/13/14/15/16/17/18/20/21
3	36	30	6	1/13/14/15/16/ 17/18/20/21
4	44	37	7	1/6/13/14/15/16/17/19/20/21

TABLE 8 Delphi round 4 – respondent comments

Section	Pattern/ component no.	Comment	Classification of comment
Feedback	N/A	<i>“Thank you for allowing me to participate, I’ve found it very stimulating and interesting.”</i> <i>“The concluding comments appear to be a very healthy conclusion.”</i>	Personal interest in the study. Expression of support for the conclusions
2	9	<i>“Associated with pronation”</i>	Reinforces personal pattern interpretation belief.
2	14	<i>“Associated with pronation”</i>	Reinforces personal pattern interpretation belief.
2	15	<i>“Associated with pronation”</i>	Reinforces personal pattern interpretation belief.
2	22	<i>“Associated with condition”</i>	Reinforces personal pattern interpretation belief.
Feedback	N/A	<i>“Completion did take a little longer than a few minutes!”</i> <i>“Results should be nteresting.”</i>	Alludes to difficulty of required task. Personal interest in the study.
Feedback	N/A	<i>“I think the statement in no. 8 is very significant and ...”</i> <i>“...that the sole and upper materials are very important as well.”</i> <i>“A soft foam rubber type sole I think will give much more information than a hard leather sole.”</i>	Refers to the potential for many influences to affect shoe wear patterns. Refers to the effect of the foot on other components of the shoe. Refers to material influence on wear pattern clarity.

TABLE 10 Respondent comments analysis from the pre-questionnaire survey

Comment received	Classification of comment
"There are some examples of shoe wear marks in a book called <i>Clinical Orthopaedic Examination</i> ."	Helpful advice (re: where to find published examples of wear patterns)
"I felt I could identify more conditions if you also had the corresponding shoe."	
"... would also require to be examined."	Information beyond shoe wear alone required to identify related conditions
"It is extremely difficult to isolate conditions from the shoes alone. Patient examination is absolutely necessary."	
"...as many of the abnormalities you have listed present with similar sole marks."	
"All (3 conditions) give a similar picture."	Wear patterns are similar with different pathologies
"... sorry, upper of shoe."	Upper of shoe also affected
"...the upper"	
"I apologise for my inability to help you, but I don't pay enough attention to shoe wear marks to be able to offer any valuable contribution."	
"I am afraid that I would only feel confident in identifying shoe wear in the (2) cases shown above - I know that this falls short of the minimum of 3 conditions requested."	
"...but realise that if you want some in-depth knowledge of this, I am not able to give it as I no longer have a clinical role in the department."	
"...and I am sorry that I was unable to give you a more positive answer."	
"As I did this however I became increasingly aware that I would have great difficulty in naming - with any certainty - specific conditions from shoe or footwear wear marks."	
"Although not quite what you asked for I have concluded and presented below the only situations in which I could confidently predict what wear marks would develop."	
"...but as your questionnaire proves, this is not as easy as might first be thought."	
"...but as to the certainty of predicting which distinct entity is responsible for precipitating these wear marks - well that's what your research is for."	
"I would be unable to make a differential diagnosis on biomechanical abnormalities."	Personal knowledge levels insufficient to answer the questions

"I have asked at my staff meeting for anyone who would be willing to fill this form in with you and I'm afraid that I got no takers."	
"Best wishes"	Belief in project value
"I wish you every success in your investigations"	
"Good luck with your survey"	
"Best of luck."	
"...and look forward to reading the results."	
"Look forward to publication."	
"I hope that my response will be of some help to you"	Belief in project value
"...however I was until recently a Clinical Manager and I concur with some of your aims."	
"...I have therefore filled in this form myself"	
"I carefully read through your list of podiatric and related pathomechanical conditions."	
"...in order that I should complete the questionnaire as requested"	
"I am well aware that a lot of patients do have shoe wear as a result of their problem."	
"I believe that you are quite correct when you state that most clinicians think that they could diagnose from footwear the nature of a patients pedal troubles"	
"...and when identifying footwear for diabetics or rheumatoids I always check wear patterns on shoes."	Beliefs that wear patterns have potential clinical value
"It would seem that 2 and 3 are base level pathomechanics that could be readily recognised"	
"I apologise for the delay in returning this to you."	Miscellaneous irrelevant comments
"At random."	Possible protocol deviation

TABLE 11 Total and mean numbers of patterns given for each pathology in main questionnaire

Total and mean no. patterns for each pathology		
Condition	Total no. patterns	Mean no. patterns given by each respondent for each pathology
Pronation	129	2.3
Hallux rigidus	85	1.5
Pes cavus	104	1.9
Rearfoot varus	107	1.9
Overall total	425	7.6

TABLE 12 Numbers of named variables given in main questionnaire

Numbers of named variables given/condition	
Main condition	No. second-named conditions given
Pronation	71
Hallux rigidus	32
Pes cavus	49
Rearfoot varus	49
Total	201

TABLE 13 Functional analysis of data relating to patterns occurring with pronation

Function	No. supporting patterns	Common wear components	Function implied from the wear pattern within the pathological context	No. variables compatible with	Wear variations noted
Foot pronated prior to heel strike and throughout stance	27	Medial heel Medial met.	Med. heel wear implies pronation before heel strike. Med. met. wear suggests pronation is maintained	19/19	Heel wear Tip wear
Foot pronated before heel strike with attempted recovery through supination	5	Medial heel Central met.	Med. heel wear implies pronation, central met. wear suggests attempted recovery	5/5	Met. wear 1 st toe area
Foot pronates rapidly on contact and remains pronated	5	Lat. or post. heel Medial heel Med. Met. area	Heel wear suggests rapid change from inversion to eversion with eversion. Med. met. wear suggests pronation is maintained throughout stance	2/2	Degrees of heel inversion/eversion
Foot pronates rapidly on contact with attempted recovery through forefoot supination	5	Medial and lateral heel Central met.	Heel wear suggests rapid change from inversion to eversion, central met. wear suggests attempted recovery	2/2	
Foot contacts normally with mid-stance pronation and no attempt to recover	24	Post. lat. heel Med. forefoot	Heel wear suggests normal heel strike. Med. forefoot wear suggests later pronation	3/3	1 st toe area Heel differences Med. met. differences
Foot contacts normally with late pronation	4	Post. lat. heel 1 st and 5 th MPJt	Heel wear suggests normal heel strike. 1 st MPJt wear suggest pronation and 5 th MPJt wear suggests that this has been late	4/4	Central met. wear presence/absence 1 st toe area wear presence/absence
Foot contacts normally with later pronation and attempt to stabilise with functional hallux limitus	18	Post. lat. heel (in 14/18 patterns) 1 st toe area Absent 1 st MPJt (in 17/18 patterns)	Pronation only known through reported context. Absent 1 st MPJt wear with 1 st toe wear suggests that hallux limitus has prevented full pronation from taking place.	11/11 (with 1 pattern having 2 theoretical causes)	Heel wear differences Met. area differences 1 st toe wear variations Tip wear inclusion
Heel equinus causing centralised heel contact and later pronation to compensate	8	Post. heel Med. forefoot	Post. heel wear suggests central heel strike such as may be related to equinus. Med. forefoot wear suggests later pronation	4/4	Met. wear variations 1 st toe wear variations One pattern with ILA wear
Heel equinus causing no heel contact and later pronation to compensate	7	Absent heel strike related wear	No heel wear = no heel strike. Reported pronation and med. forefoot wear (where present) suggest later pronation	3/3 (but no supportive links offered)	Medial forefoot wear tendency Across met. wear tendency Absent forefoot wear
Heel equinus causing no heel contact and later abductory twist to compensate	5	Absent heel wear Localised at MPJt	No heel wear = no heel strike. Localised MPJt wear implies abductory twist	4/4	1 st and 2 nd met. involvement differences
Foot lands and remains in inversion to compensate for pronation	2	Post. lat./ lat. heel Lat. forefoot wear	Lateral wear throughout implies inversion at heel stike, maintained throughout stance.	1/1	Degrees of lat. heel wear

Foot lands in inversion to compensate for pronation, then pronates fully	8	Lat.inclined heel Med. forefoot/met.	Lat. inclined heel wear suggests inversion at heel strike. Med. forefoot/ met. wear implies later eversion through pronation has occurred.	4/4	Lat. spread of heel wear Spread of med. met. wear Tip wear
Foot inverts on heel strike, then later pronates fully	2	Lat. extended heel and met.	Normal, laterally extended heel wear implies inversion after heel strike. Lat. extended met. wear suggests inversion has been maintained before finally pronating	1/1	-
Foot in fixed pronation with walking on heels, abducted feet and early lift with no toe-off	2	Lat. inclined heel No forefoot wear	Lat. inclined heel wear seen with absent forefoot wear suggests abduction with walking on heels and early lift to avoid a rigid pronation	1/1	-
Abductory twist	26	Post. lat./ lat. heel Localised, circular met. area 1 st toe area (19/26 patterns only)	Normal or lat. heel wear suggests normal or lat. heel strike. Localised, circular met. area wear suggests abductory twist with 1 st toe wear suggesting later medial toe-off.	17/17	Degree of lat. heel wear MPJt. Area wear differences 1 st toe involvement Tip wear
Foot abducted	30	Post. lat. heel Med./ant. med. forefoot	Contra-lateral post. lat heel and med. ant. forefoot wear suggest walking “across” foot through abduction.	11/11 (some also suggesting abductory twist)	Different angles of lat. heel wear Med. forefoot wear spread 1 st toe area involvement Tip wear involvement

TABLE 14 Functional analysis of data relating to patterns occurring with hallux rigidus

Function	No. supporting patterns	Common wear components	Function implied from the wear pattern within the pathological context	No. variables compatible with	Wear variations noted
"Classic" hallux rigidus function	30	1 st toe area wear Absent 1 st MPJt wear Central/lat. met. area wear	1 st toe wear implies 1 st toe restriction encountered. Absent 1 st MPJt wear implies splinting effect of stiff 1 st toe. Central/lat. met. wear suggests necessary inversion to avoid 1 st toe restriction.	10/11	Heel wear variations Spread of central/lat. MPJt wear 1 st toe wear variations Tip wear
Abducted gait	13	Ant. med. forefoot wear	Ant. med. forefoot wear suggests take-off from medial border of forefoot while foot is abducted	2/2	Heel wear absence 1 st MPJt wear absence 2 nd /3 rd MPJt absence 1 st toe wear variations Tip wear
Pronation with abducted gait	7	1 st toe area wear Med. heel wear (6/7 patterns)	Med. heel wear implies foot landing in pronation and abduction 1 st toe wear indicates maintained abduction	4/4	Heel wear variations 1 st MPJt involvement Central MPJt wear 1 st toe wear variations
No med. or lat. deviation from normal gait pathway	18	Focus of wear towards distal aspect of 1 st toe Absent lat. met. wear (16/18 patterns)	Absent lat. met. wear indicates lack of inversion. Wear focused on distal aspect of 1 st indicates continued lack of medial or lateral deviation	6/6	Absent/amended lat. inclined heel wear Met. involvement Distal 1 st toe variations Tip wear
Abductory twist	10	Localised MPJt wear 1 st toe area wear	Localised MPJt wear indicates abductory twist. 1 st toe wear suggests following medial toe-off	4/5 (The 5 th variable contradicting)	Absent heel wear MPJt wear variations 1 st toe involvement
Compensatory supination/inversion of the foot	3	Lateral heel wear Lateral forefoot wear	Lat. wear throughout suggests maintained inversion	1/1	Post. spread of heel wear Ant. spread of forefoot wear 1 st toe area Tip wear
Forefoot inversion	15	Lateral forefoot wear Post. lat. heel wear (13/15 patterns)	Normal heel wear indicates normal heel strike (Where no heel wear is shown, heel strike could be absent) Lat. forefoot wear implies later inversion of forefoot	6/6	Absent heel wear Lat. forefoot variations
Abducted gait with eversion	6	Med. heel wear (5/6 patterns) 1 st toe wear (5/6 patterns)	Medial heel wear suggests medial heel strike. Medial wear throughout suggests maintained medial pathway, in turn suggesting an abducted, everted foot	2/2	Absent heel wear Heel wear variations 1 st MPJt+ toe wear

Adducted gait	2	5 th MPJt area wear	Pattern 1 = medial heel + 5 th MPJt + apex of 1 st toe wear suggesting an initial adduction moving laterally Pattern 2 = no heel wear + 1 st MPJt + ant. lat. wear indicating a laterally inclined force pathway and therefore adducted gait	1/1	Med. heel wear Apex of 1 st toe wear Absent heel wear 1 st MPJt wear Ant. lat. wear
Stamping gait	1	Absent heel wear Central met. area wear Absent anterior wear	Absent heel and anterior wear suggests no heel strike or toe-off. Central met. wear suggests met. area involved in stance with landing and take-off therefore being at a steep vertical angle.	-	-
Adductory twist	5	1 st MPJt area wear Tip 1 st wear (3/5 patterns)	Localised 1 st MPJt wear in the presence of H.rig. and no lat. heel wear suggests adductory twist to avoid hallux restriction	2/2	Absent heel wear Tip 1 st wear 5 th MPJt + toe wear Tip wear
Calcaneal gait	1	Post. lat. heel wear No forefoot wear	Heavy heel wear could suggest excessive ankle dorsiflexion and diffused weight-bearing across rest of outsole	1/1	-
Walking predominantly on the heels	1	Post. lat. heel wear No forefoot wear	Heavy heel wear with no forefoot wear may indicate weight bearing on heels only	1/1	-
Vertical toe-off	1	Absent heel wear Central met. area wear Absent anterior wear	Absent anterior wear suggests vertical lift, avoiding normal toe off function.	-	-

TABLE 15 Functional analysis of data relating to patterns occurring with pes cavus

Function	No. supporting patterns	Common wear components	Function implied from the wear pattern within the pathological context	No. variables compatible with	Wear variations noted
Normal force pathway in the transverse plane with no toe-off propulsion	44	Heel wear (varied) Metatarsal wear (varied)	Heel wear suggests heel strike has taken place Met. wear suggests met. weight bearing Absent anterior wear suggests absent toe-off Tip wear suggests scuffing	17/20	Heel wear differences Met. wear variations Tip of 1 st wear Tip wear
Normal force pathway with forefoot loading from dropped forefoot, no heel strike and no toe propulsion	16	Absent heel wear Absent wear ant. to met. area 1 st + 5 th MPJt wear	Absent heel wear suggests no heel strike. Absent anterior wear suggests no toe-off 1 st +5 th MPJt wear suggests accentuated weight bearing of that area	7/7	Presence of wear across met. area
Foot inverted throughout stance	5	Lat. heel wear Lat. forefoot wear	Lat. heel wear suggests inversion on heel strike Lat. forefoot wear suggests inversion is maintained	2/2	Degree of lat. heel wear Ant. spread of lat. forefoot wear 1 st MPJt wear Tip wear
Foot inverted and abducted throughout stance	5	Lat. heel wear Lat. forefoot wear	Lat. heel wear suggests inverted + abducted position. 5 th MPJt wear suggests inversion	2/2	Degree of lat. heel wear Ant. spread of lat. forefoot wear 1 st MPJt wear Tip wear
Foot inverted on heel strike with a normal force pathway at the forefoot	4	Lat. heel wear 1 st and 5 th MPJt wear	Lat. heel wear suggests inversion at heel strike 1 st and 5 th MPJt wear suggests reversion to normal inclination later in stance	1/1	Post. spread of heel wear 4 th MPJt wear 1 st toe variations
Normal heel strike, inverted forefoot	7	Post. lat./post. heel wear 5 th MPJt wear Absent 1 st MPJt wear (6/7 patterns)	Heel wear shows normal heel strike Post. lat. extended 5 th MPJt wear or absent 1 st MPJt wear indicates forefoot inversion	3/3	Post. heel wear Central MPJt wear Localised 1 st MPJt wear Toe/tip wear 5 th toe wear
Normal or inverted heel, everted forefoot	14	Post. lat./lat. heel wear Med. forefoot wear	Various heel wear forms suggest either normal or inverted heel strike. Medial forefoot wear (either of 1 st MPJt only, or with medial emphasis) suggests everted forefoot	5/5	Heel wear variations Involvement of 2 nd to 5 th MPJt wear 1 st toe wear variations 5 th toe area wear
Everted heel and forefoot	2	Medial heel wear 1 st MPJt wear Absent lateral wear	Medial wear emphasis throughout suggests medial weight-bearing and therefore eversion throughout stance	2/2	Heel wear differences

Everted heel, inverted forefoot	1	Medial heel wear Wear across MPJt area Tip wear	Medial heel wear suggests everted heel Wear across MPJt area suggests foot later inverts from this position	-	-
Feet abducted	5	Post. heel wear 1 st MPJt wear (4/5) 1 st toe wear (4/5)	Posterior heel wear suggests normal heel strike with later medial forefoot wear emphasis suggesting abducted gait	2/2	Inclusion and siting of 1 st toe wear Central and lat. met. wear
Feet adducted	1	Medial heel wear Laterally inclined tip wear	Medial heel wear indicates medial heel strike Laterally inclined tip wear suggests the force pathway has moved laterally, implying adduction	-	-
No heel strike through dropped and inverted forefoot with pes cavus	1	No heel wear Lat. forefoot wear	Lack of heel wear implies no heel strike through dropped forefoot position. Lat. forefoot wear suggests inverted forefoot	1/1	-
No heel strike through dropped and everted forefoot with pes cavus	3	No heel wear 1 st MPJt wear	Lack of heel wear implies no heel strike through dropped forefoot position. 1 st MPJt wear implies forefoot eversion	2/2	Involvement of 2 nd and/or 5 th MPJt wear
Abductory twist	3	No heel wear Localised MPJt wear	Lack of heel wear implies pes cavus relationship of forefoot v. rearfoot Localised MPJt wear suggests abductory twist	3/3	MPJt wear variations
Adductory twist	1	Post. lat heel wear 1 st toe wear 2 nd + 5 th MPJt wear	Heel wear indicates normal heel strike 1 st toe wear with 2 nd + 5 th MPJt wear in a pes cavus context implies that an adductory twist around the 2 nd MPJt has taken place with take-off along the 1 st toe, 5 th MPJt axis.	1/1	-
Dorsiflexion of the foot with load bearing (heavily) on the heel	2	No common factors	Pattern 1 showed heavy post. lat. heel wear only implying heavy load bearing on the heel only and hence dorsiflexion of the forefoot Pattern 2 showed wear of the entire heel unit implying greater load bearing on the heel, again with dorsiflexion after heel strike	-	Absent forefoot wear Heel area wear differences
Shuffling gait	1	Wear of the entire outsole	Complete outsole wear suggests a predominate horizontal shuffling of the foot with minimal ground clearance	-	-
Foot contacts and lifts with a steep vertical angle and dragging of the tip through retraction	2	Tip wear Apex of 1 st wear Absent heel wear Absent met. area wear	Absent heel and met. area wear suggests that the foot may have entered and left stance at a steep angle, avoiding damaging shearing stress. Tip wear suggests dragging at toe-off	1/1	-

TABLE 16 Functional analysis of data relating to patterns occurring with rearfoot varus

Function	No. supporting patterns	Common wear components	Function implied from the wear pattern within the pathological context	No. variables compatible with	Wear variations noted
Foot inverted on heel strike, remaining inverted throughout stance	30	Post. lat./lat. heel wear 5 th MPJt wear Absent 1 st MPJt wear	The predominately lateral wear suggests a maintained inversion throughout stance	10/10	Degrees of lat. heel wear Extension of lat. forefoot wear 1 st toe and tip wear
Foot inverted on heel strike, reverting to normal inclination at the forefoot	9	Post. lat./post. heel wear 1 st and 5 th MPJt wear	Heel wear shows strike of at least normal inversion. 1 st and 5 th MPJt wear shows normal inclination through medial and lateral weight bearing	10/10	Central MPJt wear Ant. spread of 5 th MPJt wear Greater or lesser degrees of post. heel wear
Foot inverted on heel strike followed by pronation	15	Lat./post. lat. heel wear Med. forefoot wear	Laterally inclined heel wear implies a heel inversion at heel strike Medial forefoot wear suggests that the foot has pronated with subsequent medial weight bearing emphasis	7/7	Lat. inclination of heel wear 1 st toe, central and lat.MPJt wear Ant. med. heel wear
Foot inverted and abducted throughout stance	32	Post. lat./lat. heel wear No 1 st MPJt wear 5 th MPJt wear (25/32 patterns)	Laterally inclined heel wear with absent 1 st MPJt wear and 5 th MPJt wear (when present) suggest forefoot inversion, possibly with abduction	6/12	Lat. heel wear inclination 1 st toe area wear Ant. spread of lat. forefoot wear MPJt areas involved
Foot inverted and abducted throughout stance with walking on heels	13	Lat. heel wear Absent central MPJt. Wear Absent medial forefoot wear	Lat. heel wear suggests inversion and abduction at heel strike. Absent central and medial forefoot wear suggests minimal weight bearing at these sites with walking on heels	1/1	Lat. heel wear spread Lat. post. forefoot wear involvement
Foot inverted and adducted (intoed) throughout	13	Post. lat./lat. heel wear Lat. forefoot wear Absent med. forefoot wear	Lat. heel and forefoot wear imply inversion of the foot throughout stance. Complete absence of med. wear suggests that an adductory position has prevented wear on this aspect of the shoe	2/2	Degrees of lat. heel wear Lat. forefoot wear spread Tip wear
Foot pronates prior to heel strike to compensate for rearfoot varus, remaining pronated	10	Post./med. inclined heel wear Med. met. wear	Medially inclined wear implies medial heel strike with weight bearing remaining medial such as may be caused by pronation before or just on weight bearing	6/6	Angles of med. heel wear Ant. med. heel wear Spread of med. forefoot wear
Foot lands in pronation, going into rearfoot varus to compensate	3	Lat. forefoot wear Central MPJt wear Absent 1 st MPJt wear Med. heel wear (2/3 patterns)	Medial or absent heel wear implies pronation prior to heel strike. Laterally biased forefoot wear suggests later inversion	2/2	Absent heel wear Central MPJt. wear 1 st toe are wear Tip wear

Foot lands in inversion, then pronates with abductory twist to compensate	11	Post. lat./lat. heel wear Central MPJt wear	Heel wear implies an inverted heel strike. Central met. wear suggests that this inversion has not been maintained in the forefoot – a situation requiring pronation. Localised central MPJt wear implies abductory twist	5/5	Lat. heel variations Central met. variations Ant. med. heel wear
Inversion with heel equinus leading to absent heel strike and pronation	1	Absent heel wear Central + medial MPJt wear	Absent heel wear suggests absent heel strike through heel restrictions. Central and medial MPJt wear with no 5 th MPJt wear implies medially inclined weight bearing as in pronation	1/1	-
Inversion with heel equinus leading to absent heel strike and compensation via abductory twist	2	Absent heel wear Central MPJt wear only	Absent heel wear may result from heel inversion with equinus which could be compensated by STJ pronation which may lead to abductory twist	2/2	Spread of central MPJt wear
Forefoot supination (with or without adductory twist)	3	Lat. forefoot wear Absent 1 st MPJt wear 1 st toe area wear 2 nd MPJt wear (2/3 patterns)	Laterally predominant wear suggests that the forefoot is inverted (supinated) with the rearfoot varus. Where 2 nd MPJt wear is also present, adductory twist may also be suggested	1/1	Absent heel wear Ant. situation of lat. forefoot wear Central MPJt wear 1 st toe wear variations Tip wear
Compensatory eversion with abduction	4	Absent forefoot wear Med. heel unit wear	Wear of various areas of the med. heel unit suggests eversion of heel with abduction through pronation. Predominant med. heel weight bearing through this position avoids forefoot wear	1/1	Varied med.and ant. med. heel wear

TABLE 17 Levels of support offered by named variables for function categories suggested with pronation

Pattern ref.	Named variable	Level of support	Pattern ref.	Named variable	Level of support
1. Heel equinus causing centralised heel contact and later pronation to compensate					
PRON 43/3	Intoed gait	NC	PRON 34/1	Pron. from h.s.	NC
PRON 18/2	Equinus	DS	PRON 23/2	Severe. Fixed	NC
PRON 44/2	Rearfoot valgus	IS	PRON 50/2	Comp. H'bobble	IS
PRON 53/4	Red. STJ movement	NC	PRON 48/2	Genu valgum	IS
2. Foot pronated prior to heel strike and throughout stance					
PRON 51/4	Heel eq. Mid-tarsal pron.	NC	PRON 6/2	Fixed pron.	DS
PRON 18/3	Pron. from h.s.	DS	PRON 20/3	F'f varus	NC
PRON 14/2	Rigid	DS	PRON 16/2	Pes planus	DS
PRON 8/3	F'f varus	NC	PRON 28/2	Pes planus	DS
PRON 17/2	Pron. from h.s.	DS	PRON 51/2	Rearfoot valgus + pl. fl. 1 st ray	IS
PRON 11/2	Rearfoot valgus	IS	PRON 2/2	Severe	IS
PRON 5/2	Rearfoot valgus	IS	PRON 15/2	Severe	IS
3. Foot pronated prior to heel strike with attempt to recover via supination					
PRON 13/2	H'mobile 1 st ray	NC	PRON 21/3	Severe with MPJt involvement	NC
PRON 21/2	Severe pron. from h.s.	DS	PRON 31/3	Pron. from h.s.	DS
4. Foot pronates rapidly and remains pronated throughout stance					
PRON 54/4	Fixed	DS	PRON 54/3	Pron. from h.s.	DS
5. Foot pronates rapidly on contact and attempts to recover via forefoot supination					
PRON 26/2	Tib. sesamoiditis	IS	PRON 26/3	Abductory twist	NC
6. Foot contacts normally with mid-stance pronation and no attempt to recover					
PRON 47/4	Hypermobility	NC	PRON 34/4	Fully comp.	NC
PRON 52/2	Comp. Rearfoot varus	DS			
7. Foot contacts normally with late pronation					
PRON 34/3	Partially comp.	NC	PRON 21/4	Abductory twist	NC
PRON 50/4	Partially comp.	NC	PRON 21/1	Late 2ndary pron.	DS
8. Foot contacts normally with late pronation and attempt to stabilise via functional hallux limitus					
PRON 32/2	Functional hallux limitus	DS	PRON 35/2	Abductory twist	NC
PRON 46/2	Rolling off med.border	IS	PRON 31/2	Abductory twist	NC
PRON 11/4	Comp. Rearfoot and RF varus	NC	PRON 20/2	Abducted gait	NC
PRON 43/1	H'mobile 1 st ray	IS	PRON 24/2	H. lim. + d'flexed 1 st met.	DS
PRON 37/2	Abductory twist	NC	PRON 54/2	H'mobile	IS
PRON 11/3	Abductory twist	NC			
9. Heel equinus causing no heel contact and later pronation to compensate					
PRON 47/3	Pron. f' foot	IS	PRON 12/2	Comp.	IS
PRON 32/3	Pron. from h.s.	NC			
10. Heel equinus causing no heel contact and later abductory twist to compensate					
PRON 32/4	Abductory twist	DS	PRON 22/2	H'mobile 1 st ray	NC
PRON 5/3	Pl. fl. 1 st ray	NC	PRON 17/3	Abductory twist	DS
11. Foot lands in inversion to compensate for pronation and remains inverted throughout stance					
PRON 34/2	Rearfoot varus	DS			
12. Foot lands in inversion to compensate for pronation, then later pronated fully					
PRON 51/1	Severe	NC	PRON 43/2	Severe	IS
PRON 51/3	Rearfoot varus + pl. fl. 1 st ray	DS	PRON 50/3	HAV	NC
13. Foot inverts on heel strike, then later pronates fully					
PRON 28/4	Equinus. Full comp.	NC			
14. Foot in fixed pronation and walking on heels in abduction with early lift					
PRON 25/2	Comp. rearfoot varus	IS			
15. Abductory twist					
PRON 42/2	D'flexed 1 st +5 th MPJts	NC	PRON 11/3	Abductory twist	DS
PRON 8/2	Pl. fl. 2 nd +3 rd MPJts	NC	PRON 53/2	Pl. fl. 1 st ray	NC
PRON 16/3	Partial comp.	IS	PRON 20/2	Abducted gait	IS
PRON 35/2	Abductory twist	DS	PRON 31/2	Abductory twist	DS
PRON 43/1	H'mobile 1 st ray	NC	PRON 24/2	H. Lim. + d'flexed 1 st met.	IS
PRON 37/2	Abductory twist	DS			
16. Foot abducted					
PRON 34/4	Fully comp	NC	PRON 43/1	H'mobile 1 st ray	NC
PRON 52/2	Comp. RF varus	NC	PRON 35/2	Abductory twist	IS
PRON 51/1	Severe	NC	PRON 37/2	Abductory twist	IS
PRON 35/3	Arthritis	NC	PRON 11/3	Abductory twist	IS
PRON 31/2	Abductory twist	IS	PRON 50/3	HAV	IS
PRON 54/2	H'mobile	NC			

(DS = Direct support IS = Indirect support NC = Not contradicted C = Contradicted)

TABLE 18 Levels of support offered by named variables for function categories suggested with hallux rigidus

Pattern ref.	Named variable	Level of support	Pattern ref.	Named variable	Level of support
1. Classic hallux rigidus function					
HR 16/2	Pain in hallux	IS	HR 26/2	Pl. fl. 5 th ray	NC
HR 51/2	Pain in hallux, 5 th +MPJt loading+ff inv. varus	DS	HR 29/2	Partial comp	NC
HR 25/2	5 th MPJt loading	IS	HR 20/2	Equinus	NC
HR 42/2	Forefoot inv. varus	DS			
2. Abducted gait					
HR 32/4	Abducted gait	DS			
3. Pronation with abducted gait					
HR 48/3	Abducted gait	DS	HR 31/2	Fixed rearfoot deformity	NC
HR 12/2	Excessive pron.	DS			
4. No medial or lateral deviation from normal gait pathway					
HR 14/2	Large exo. 1 st met.	NC	HR 5/2	Excess wear prox.phal. 1 med.	IS
HR 11/3	IPJt extn.	IS	HR 8/2	Os. arthritis	NC
HR 14/1	IPJt extn.	IS			
5. Abductory twist					
HR 23/1	Adducted gait	C	HR 46/2	Abductory twist	DS
HR 32/2	Abductory twist	DS	HR 50/2	Overloaded 2 nd MPJt	IS
6. Compensatory supination/inversion of the foot					
HR 5/3	Supination	DS	HR 53/2	Pain in hallux	IS
HR 11/2	Supination	DS	HR 31/3	Pl.fl. 1st	IS
7. Forefoot inversion					
HR 32/3	Late lat. load transfer	IS			
8. Abducted gait with eversion					
No variables named with patterns suggesting this function					
9. Adducted gait					
HR 48/4	Adducted gait	DS			
10. Stamping gait					
No variables named with patterns suggesting this function					
11. Adductory twist					
No variables named with patterns suggesting this function					
12. Calcaneal gait					
HR 32/4	Abducted gait	NC			
13. Walking predominately on heels					
HR 32/4	Abducted gait	NC			
14. Vertical toe off					
No variables named with patterns suggesting this function					

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TABLE 19 Levels of support offered by named variables for function categories suggested with pes cavus

Pattern ref.	Named variable	Level of support	Pattern ref.	Named variable	Level of support
1. Normal force pathway with increased forefoot loading and no toe off propulsion due to pes cavus					
PC 13/1	Forefoot valgus	NC	PC 48/3	Flexible 1 st	NC
PC 18/2	Rigid pl. fl. 1 st +5 th MPJts	DS	PC 20/2	Shuffling	NC
PC 24/2	Rigid pl. fl. 1 st +5 th MPJts	DS	PC 54/2	Calc.cavus	NC
PC 42/1	Rigid	NC	PC 8/2	Some MPJt mobility	NC
PC 51/2	Pl. fl. 1 st +5 th MPJts	DS	PC 6/2	Mobile 1 st + 5 th rays	NC
PC 2/2	Inc. 1 st + 5 th ray angle	DS	PC 42/3	Fully comp.	NC
PC 26/3	Pl. fl. 2 nd	IS	PC 8/3	Trigger 1 st	IS
PC 55/2	Rigid	NC	PC 29/2	Comp.	NC
PC 42/2	Part. comp.	NC	PC 43/2	Flexible 1 st	NC
PC 13/2	Prominent mets.	DS	PC 26/2	MP Elevatus	DS
2. Normal force pathway, forefoot loading, no toe off due to pes cavus+ no heel strike through dropped forefoot					
PC 46/2	Inc. shear	IS	PC 1/3	Equinus. Pl. fl. f' foot	DS
PC 5/2	Rigid	NC	PC 27/2	Short TA	DS
PC 54/3	Equino-cavus	DS	PC 13/3	F'foot equinus	DS
PC 5/3	With equinus	DS			
3. Foot inverted throughout stance					
PC 51/4	Rigid sup. calc.	DS	PC 28/2	Polio/cva	NC
4. Foot inverted and abducted throughout stance					
PC 51/4	Rigid sup. calc.	DS	PC 28/2	Polio/cva	NC
5. Foot inverted on heel strike, normal force pathway					
PC 33/2	Rigid	NC			
6. Normal heel strike, inverted forefoot					
PC 31/3	Pl. fl. 1 st	NC	PC 24/3	F'f equinus + d'fl. 1 st +5 th mets.	NC
PC 15/2	Lat. bearing	DS			
7. Normal or inverted heel, everted forefoot					
PC 12/2	Rigid	NC	PC 48/1	+ RFV	DS
PC 1/2	Pl. fl. 1 st ray	DS	PC 48/4	Abducted gait	NC
PC 28/3	Developed + clawing of toes	NC			
8. Everted heel and forefoot					
PC 12/3	Flexible	NC	PC 51/3	Pl. fl. 1st	DS
9. Everted heel, inverted forefoot					
No variables named with patterns suggesting this function					
10. Feet abducted					
PC 12/2	Rigid	NC	PC 48/4	Abducted gait	DS
11. Feet adducted					
No variables named with patterns suggesting this function					
12. No heel strike due to dropped forefoot and inverted forefoot					
PC 32/2	Excess lat. load	DS			
13. Dorsiflexion of foot with lead bearing (heavily) on heel					
No variables named with patterns suggesting this function					
14. No heel strike due to dropped forefoot and inverted heel					
PC 47/3	Rigid + abd. twist	NC	PC 47/4	Abd. twist	NC
15. Abductory twist					
PC 47/3	Abd. Twist	DS	PC 22/2	Mobile	NC
PC 47/4	Abd. twist	DS			
16. Adductory twist					
PC 53/2	Comp.	NC			
17. Shuffling gait					
No variables named with patterns suggesting this function					
18. Foot placed down and lifted vertically, with dragging of toes at toe off due to retraction					
PC 47/2	Pronation	NC			

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TABLE 20 Levels of support offered by named variables for function categories suggested with rearfoot varus

Pattern ref.	Named variable	Level of support	Pattern ref.	Named variable	Level of support
1. Foot inverted on heel strike, remaining inverted throughout					
RFV 24/2	Part. comp. + pl. fl. 1 st	NC	RFV 16/2	Part. comp.	NC
RFV 52/4	Rigid	DS	RFV 48/1	Rigid	DS
RFV 35/2	Part. comp.	NC	RFV 52/3	Part. comp.	NC
RFV 53/4	V. little comp.	DS	RFV 20/3	Abducted gait	NC
RFV 53/2	Part. comp.	NC	RFV 12/2	Comp.	C
2. Foot inverted on heel strike, reverting to normal inclination at forefoot					
RFV 53/3	Pl. fl. 1 st ray	DS	RFV 34/3	Part. comp.	DS
RFV 26/3	Uncomp. + pl. fl. 1 st	DS	RFV 1/1	Comp. by STJ pron.	DS
RFV 24/2	Part. comp. + pl. fl. 1 st met.	DS	RFV 42/2	Comp.	DS
RFV 2/3	Part. comp.	DS	RFV 24/1	Comp.	DS
3. Foot inverted on heel strike, followed by pronation					
RFV 18/2	Pl. fl. 1 st ray	IS	RFV 5/2	Comp.	DS
RFV 34/4	Comp.	DS	RFV 51/2	Comp. by STJ pron.	DS
RFV 11/2	Comp.	SD	RFV 52/2	Comp.	DS
RFV 1/2	Pl. fl. 1 st ray	IS			
4. Foot inverted throughout with abduction					
RFV 34/2	Fixed RFV	DS	RFV 20/2	Abd. Gait. Equinus	DS
RFV 52/4	Rigid	DS	RFV 31/2	Abd. twist	IS
RFV 35/2	Part. comp.	NC	RFV 48/1	Rigid	DS
RFV 53/4	V. little comp.	DS	RFV 52/3	Part. comp.	NC
RFV 53/2	Part. comp.	NC	RFV 12/2	Comp.	NC
RFV 35/3	Comp.		RFV 20/3	Abd. gait	DS
5. Foot inverted throughout stance with abduction and walking on heels					
RFV 8/2	Part. comp.	NC			
6. Foot inverted throughout with adduction (intoeing)					
RFV 34/2	Fixed RFV	DS	RFV 52/4	Rigid	NC
7. Foot pronated prior to heel strike and throughout stance					
RFV 11/3	Comp.	IS	RFV 33/3	Comp.	IS
RFV 7/2	Pl. fl. 1 st ray		RFV 55/2	Part. comp.	IS
RFV 18/4	Comp.	IS	RFV 28/3	Comp.	IS
8. Foot lands in pronation, then transfers to inversion to compensate					
RFV 51/3	O'loaded 2 nd MPJt	NC	RFV 31/3	Pron. from h.s.	DS
9. Foot lands in inversion, the pronates with abductory twist to compensate					
RFV 18/3	Part. comp.	IS	RFV 13/2	Flexible f' foot	NC
RFV 23/2	Part. comp.	IS	RFV 5/3	Part. comp.	IS
RFV 54/3	Part. comp.	IS			
10. Inversion with heel equinus leading to no heel strike and pronation					
RFV 6/1	Comp.	IS			
11. Inversion with heel equinus leading to no heel strike and compensation via abductory twist					
RFV 22/2	Comp. by STJ pron.	IS	RFV 32/2	Comp.	IS
12. Forefoot supination (or adductory twist)					
RFV 6/2	Part. comp. Rigid	IS			
13. Compensatory eversion with abduction					
RFV 32/3	Comp.	IS			

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TABLE 21 Named variables repeated across patterns given

Named variable	Frequency of occurrence with named pathologies			
	Pronation	Hallux rigidus	Pes cavus	Rearfoot varus
1. Abducted gait	1	2	1	2
2. Abductory twist	8	4	2	1
3. Adducted (intoed) gait	1	2	0	0
4. Arthritis	1	1	0	0
5. Calc. varus/inversion	2	0	2	0
6. Comp. pes cavus	0	0	3	0
7. Comp. pronation	3	0	0	0
8. Comp. rearfoot varus	3	0	0	18
9. D'flexed 1 st + 5 th Mets.	1	0	1	0
10. Equinus	3	1	7	1
11. Fixed/severe pronation	19	1	0	1
12. Forefoot inversion/varus	3	5	0	0
13. HAV	1	1	0	0
14. Hallux limitus	2	0	0	0
15. Hypermobile 1 st ray	3	0	0	0
16. Hypermobile pronation	3	0	0	0
17. IPJt extn.	0	2	0	0
18. Mobile pes cavus	0	0	3	0
19. Overloaded 2 nd MPJt	0	1	0	1
20. Painful hallux	0	3	0	0
21. Part. comp. pronation	3	0	0	0
22. Part. comp. rearfoot varus	0	0	0	15
23. Pl. fl. 1 st met/ray	4	1	3	6
24. Rearfoot valgus	4	0	0	0
25. Rigid pes cavus	0	0	6	0
26. Rigid pl. fl. 1 st + 5 th MPJts	0	0	2	0
TOTAL	65	24	30	45

TABLE 22 Number of statements produced in the pre-validation Delphi round 1

Section	No. statements produced	No. variables listed	Additional variables suggested	Mean no. statements/ variable
Foot/gait Pathologies	233	139	3	1.64
Gait types	66	19	3	3
Ranges of movement	62	15	0	4.13
Footwear	119	31	0	3.84
All sections	480	204	6	2.29

TABLE 23 Patterns of change for statements overall in pre-validation Delphi rounds

No. statements	Type of change
36	Oscillatory
68	Monotonic, increasing consensus
239	Monotonic, decreasing consensus
23	None - Remained static throughout
111	None - Agreed in Round 2

TABLE 24 Interobserver agreement levels achieved for paired observers

Agreement	Pair 1/2	Pair 1/3	Pair 1/4	Pair 2/3	Pair 2/4	Pair 3/4
Poor	4/15 (27%)	1/15(7%)	1/15(7%)	0/15 (0%)	1/15(7%)	0/15 (0%)
Slight	2/15 (13%)	5/15 (33%)	2/15 (13%)	4/15 (27%)	0/15 (0%)	2/15 (13%)
Fair	5/15 (33%)	3/15 (20%)	3/15 (20%)	1/15(7%)	2/15 (13%)	5/15 (33%)
Moderate	0/15 (0%)	1/15(7%)	4/15 (27%)	5/15 (33%)	4/15 (27%)	3/15 (20%)
Substantial	1/15(7%)	1/15(7%)	0/15 (0%)	0/15 (0%)	2/15 (13%)	0/15 (0%)
Perfect	3/15 (20%)	4/15 (27%)	5/15 (33%)	5/15 (33%)	6/15 (40%)	5/15 (33%)

TABLE 25 Levels of agreement achieved by individual podiatrists

Agreement	Podiatrist 1	Podiatrist 2	Podiatrist 3	Podiatrist 4
Poor	6/45 (13%)	5/45 (11%)	1/45 (3%)	2/45 (4%)
Slight	9/45 (20%)	6/45 (13%)	11/45 (25%)	4/45 (9%)
Fair	11/45 (25%)	8/45 (18%)	9/45 (20%)	10/45 (22%)
Moderate	5/45 (11%)	9/45 (20%)	9/45 (20%)	11/45 (25%)
Substantial	2/45 (4%)	3/45 (7%)	1/45 (3%)	2/45 (4%)
Perfect	12/45 (27%)	14/45 (31%)	14/45 (31%)	16/45 (36%)

TABLE 26 Classifications given by observers for pronation, pes planus and reduced arches

Classifications given by observers for pronation					
Observer	ILA Pathology	Foot type	Whole foot pathology	Forefoot pathology	Gait abnormality
1	1	9	2	4	0
2	0	8	0	0	5
3	4	8	4	0	2
4	2	7	3	0	4
Classifications given by observers for pes planus					
Observer	ILA Pathology	Foot type	Whole foot pathology	Forefoot pathology	Gait abnormality
1	5	0	3	0	0
2	0	3	0	0	0
3	1	2	1	0	0
4	1	3	3	0	0
Classifications given by observers for reduced arches					
Observer	ILA Pathology	Foot type	Whole foot pathology	Forefoot pathology	Gait abnormality
1	0	0	0	0	0
2	6	0	0	0	0
3	0	0	0	0	0
4	1	0	0	0	0

TABLE 27 No. occasions that pronation, pes planus and reduced arches were associated with the same subject, by individual observers

Conditions observed together/ subject	No. observations/observer for each combination			
	Observer 1	Observer 2	Observer 3	Observer 4
Pronation + Pes Planus	6	1	1	1
Pronation + Reduced Arches	0	4	0	0
Pes Planus + Reduced Arches	0	0	0	0
Pronation, Pes Planus + Reduced Arches	0	2	0	1

TABLE 28 Observer pairings to be used in the validation phase of the project

Condition/state to be assessed	Observer pairing selected for the assessment
Lower limb pathology	1 v 2
ILA pathology	1 v 4
Foot type	1 v 4
Heel pathology	2 v 4
Forefoot pathology	2 v 4
Hallux pathology	2 v 3
Lesser toe pathology	2 v 4
Whole foot pathology	2 v 4
Ankle pathology	2 v 4
Gait pathology	2 v 4
Range of joint movement	2 v 4
Shoe fit	1 v 3
Shoe dimensions	1 v 4
Shoe condition	2 v 4
Amount of shoe wear	2 v 4

TABLE 29 The relationship of the research aims in the validation phase, to the analysis approach adopted

Research aim	Approach to meeting research aim
Determine whether the instrument can clarify, differentiate and show similarities between shoe wear patterns in reality?	◆ Show whether the wear pattern can be presented by the instrument for every item of footwear examined. Show reasons for the grid failing to present a pattern form.
	◆ Determine whether different patterns are suggested between individuals and items of footwear by the instrument. Show reasons for differences occurring.
Determine whether the model of wear influence is justified (i.e. is wear in reality fundamentally a product of holistic foot function with foot pathology demonstrating a lower influence than primary walking intention and external factors a lower influence than foot pathology)?	<p>◆ Show whether the overriding holistic function is suggested by the wear pattern within the given contexts and therefore whether patterns observed support functions present in reality.</p> <p>◆ Demonstrate whether or not wear relates consistently and directly to foot pathologies when present.</p> <p>◆ Determine what external variables have been present, whether these have influenced the wear pattern and under what circumstances this influence has occurred.</p>

TABLE 30 Repeated wear pattern focal codes in footwear examined during the validation phase

		Footwear item reference																							
		11L	11R	12L	12R	13L	13R	14L	14R	21L	21R	22L	22R	23L	23R	24L	24R	31L	31R	32L	32R	33L	33R		
Footwear item reference	11L		✖	•	•	✖	✖	✔	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖		
	11R	✖		•	•	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖		
	12L	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		
	12R	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		
	13L	✖	✖	•	•		✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖		
	13R	✖	✖	•	•	✖		✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖		
	14L	✔	✖	•	•	✖	✖		✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖		
	14R	✖	✖	•	•	✖	✖	✖		✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖		
	21L	✖	✖	•	•	✖	✖	✖	✖		✖	✔	✖	✔	✖	✔	✖	✖	✖	✖	✖	✖	✖		
	21R	✖	✖	•	•	✖	✖	✖	✖	✖		✖	✔	✖	✔	✖	✔	✖	✖	✖	✖	✖	✖		
	22L	✖	✖	•	•	✖	✖	✖	✖	✔	✖		✖	✔	✖	✔	✖	✖	✖	✖	✖	✖	✖		
	22R	✖	✖	•	•	✖	✖	✖	✖	✖	✔	✖		✖	✔	✖	✔	✖	✖	✖	✖	✖	✖		
	23L	✖	✖	•	•	✖	✖	✖	✖	✔	✖	✔	✖		✖	✔	✖	✖	✖	✖	✖	✖	✖		
	23R	✖	✖	•	•	✖	✖	✖	✖	✖	✔	✖	✔	✖		✖	✔	✖	✖	✖	✖	✖	✖		
	24L	✖	✖	•	•	✖	✖	✖	✖	✔	✖	✔	✖	✔	✖		✖	✖	✖	✖	✖	✖	✖		
	24R	✖	✖	•	•	✖	✖	✖	✖	✖	✔	✖	✔	✖	✔	✖		✖	✖	✖	✖	✖	✖		
	31L	✖	✖	•	•	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖		✖	✔	✖	✔	✖		
	31R	✖	✖	•	•	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖		✖	✔	✖	✔		
	32L	✖	✖	•	•	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✔	✖		✖	✔	✖		
	32R	✖	✖	•	•	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✔	✖		✖	✔		
	33L	✖	✖	•	•	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✔	✖	✔	✖		✖		
	33R	✖	✖	•	•	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✖	✔	✔	✖	✔			

Key to table

- ✓

 = Focal code (i.e. pattern) match
- ×

 = Focal code (i.e. pattern) mismatch
- = Could not compare due to legibility

TABLE 31 Comparison of level and type of external variables acting on different outsoles of footwear examined

External Variable	Footwear item present in																							
	Left												Right											
	1/1	1/2	1/3	1/4	2/1	2/2	2/3	2/4	3/1	3/2	3/3	1/1	1/2	1/3	1/4	2/1	2/2	2/3	2/4	3/1	3/2	3/3		
Pain MPJt 1	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-		
Heel pain	-	-	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Bespoke insole	4	4	-	4	-	-	-	3	4	4	4	4	4	-	4	-	-	-	3	4	4	4		
Rocker sole	-	-	-	-	-	-	-	-	-	-	-	4	4	-	4	-	-	-	-	-	-	-		
Steel plate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-		
Walking	3	3	1	4	1	1	3	2	3	3	3	3	3	1	4	1	1	3	2	3	3	3		
Use outside	4	4	-	4	4	4	4	4	2	2	3	4	4	-	4	4	4	4	4	2	2	3		
Stair use	1	1	-	1	-	-	-	-	1	1	1	1	1	-	1	-	-	-	-	1	1	1		
Amount used	3	3	1	3	2	2	3	2	3	3	3	3	3	1	3	2	2	3	2	3	3	3		
Shoe stiffness	2	2	-	3	-	-	-	-	-	-	-	3	3	-	3	-	-	-	-	-	-	-		
Shoe feels too large	3	3	1	4	-	-	-	-	4	4	-	3	3	1	4	-	-	-	-	4	4	-		
High swing	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-		
Non-bespoke insole	-	-	-	-	3	3	3	-	-	-	-	-	-	-	-	3	3	3	-	-	-	-		
Wedge	-	-	-	-		4	-	-	-	-	-	-	-	-	-	-	4		-	-	-	-		
Driving	-	-	-	-	2	2	2	3	-	-	-	-	-	-	-	2	2	2	3	-	-	-		
Standing	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	1	2	-	-	-		
Support	-	-	-	-	-	2	3	-	-	-	-	-	-	-	-	-	2	3	-	-	-	-		
Plate in foot	-	-	-	-	-	-	-	-	4	4	4	-	-	-	-	-	-	-	-	-	-	-		
Dancing	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-		
Kneeling	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1		
General foot pain	-	-	-	-	-	-	-	-	4	4	4	-	-	-	-	-	-	-	-	-	-	-		
Toe pain	-	-	-	-	-	-	-	-	4	4	4	-	-	-	-	-	-	-	-	4	4	4		
High heel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Thick sole	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Shallow toe box	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Shoe short	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4	4		
Shoe too long	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Inadequate width	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4		
Too wide	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Inadequate depth	-	-	-	-	4	4	4	4	4	4	4	-	-	-	-	4	4	4	4	4	4	4		
Heel fit too loose	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Toe box tight	-	-	-	-	4	4	4	4	4	4	4	-	-	-	-	4	4	4	4	4	4	4		

Key to scores allocated

- ☐ = Variable not present
- ☐ 1 = Variable present/has been present to low degree
- ☐ 2 = Variable present/has been present to moderate degree
- ☐ 3 = Variable present/has been present to moderately high degree
- ☐ 4 = Variable present to high degree/permanently

TABLE 32 Comparison of type of internal variables acting on different outsoles of footwear examined

Internal Variable	Foot present in					
	Left			Right		
	1	2	3	1	2	3
Genu Valgum	-	-	✓	-	-	✓
Tibial Varum	✓	✓	✓	✓	✓	✓
Pronation	✓	✓	✓	✓	✓	✓
Abduction	-	✓	-	-	✓	-
Pes Planus	✓	✓	✓	✓	✓	
Hallux Rigidus	-	✓	✓	-	✓	-
Hallux Limitus	✓	-	-	✓	-	-
Elevated 1 st toe	-	✓	✓	-	✓	✓
Short 2 nd toe	-	-	✓	-	-	-
Minor pathology 4 th + 5 th	✓	✓	✓	✓	✓	✓
Clawed toes	-	✓	-	-	✓	✓
Pain in 1 st toe	-	-	✓	-	-	-
Medial metatarsal pain	-	-	✓	✓	-	-
Metatarsal area pain	-	✓	-	-	✓	✓
Calcaneal area pain	✓	-	-	-	-	-
Mid-foot area pain	-	-	-	-	-	-
Reduced dors./pl. ankle ROM	✓	-	-	✓	-	-
Inverted calc.	-	✓	-	-	✓	-
Everted calc.	-	-	✓	-	-	✓
Increased forefoot inversion	-	✓	✓	-	✓	✓
Increased 2 nd toe ROM	-	-	✓	-	-	-
Increased 3 rd toe ROM	-	-	✓	-	-	-
Increased 4 th toe ROM	-	-	-	-	-	-
Normal heel strike	-	-	-	-	-	-
Lateral heel strike	-	-	-	-	-	-
Lat/central heel strike	-	-	-	-	-	-
Normal heel strike + rapid eversion	✓	-	-	✓	-	-
Heel inversion	-	-	-	-	-	-
Heel eversion	-	-	-	-	-	-
Abducting of foot	✓	✓	✓	-	✓	✓
Foot straight	-	-	-	✓	-	-
Pronation	-	-	✓	-	-	✓
H. Lim. Preventing pronation	✓	-	-	✓	-	-
H. Rig. preventing pronation	-	-	-	-	-	-
Classic H. Rig. function	-	-	-	✓	✓	-
Medial roll off	-	-	-	-	-	-
Forefoot inverting throughout stance	-	-	-	-	-	-
Inverted forefoot	-	✓	-	-	-	-
Incompetent 1 st ray ⇒ 2 nd toe-off	-	-	✓	-	-	✓

(✓ = variable present - = variable not present)

TABLE 33 Comparison of observations with video frame analysis

Function being assessed	Function analysis		
	Podiatrist 1 Observations	Podiatrist 2 Observations	Video recorded function
Subject 1 (left foot)	Pronation Foot abducted Abductory twist	Pronation Foot abducted Abductory twist	Normal heel strike with rapid heel eversion. Foot abducted. Hallux limitus restricting pronation
Subject 1 (right foot)	Lateral heel strike Foot straight Abductory twist	Lateral heel strike Foot straight	Normal heel strike with rapid eversion, No abduction Hallux limitus restricting pronation with “classic” hallux rigidus function following
Subject 1 + footwear 1-4 (left)	Pronation Foot abducted Abductory twist	Pronation Foot abducted	Normal heel strike with rapid eversion Pronation restricted due to hallux limitus
Subject 1 + footwear 1-4 (right)	Lateral heel strike Foot straight Abductory twist	Lateral heel strike Foot straight	Foot inverted throughout stance, with no medial ground contact
Subject 2 (left)	Lateral heel strike Pronation Abducted foot Medial roll off Abductory twist Clawing of toes 2 to 5	Lateral heel strike Pronation Medial roll off Clawing of toes 2 to 5 Walks with 1 st elevated	Foot abducted during stance, with inverted forefoot
Subject 2 (right)	Lateral heel strike Pronation Abducted foot Medial roll off Abductory twist Clawing of toes 2 to 5	Lateral heel strike Pronation Medial roll off Clawing of toes 2 to 5 Walks with 1 st elevated	Foot abducted with “classic” hallux rigidus function
Subject 3 (left)	Pronation Abducted foot Medial roll off Abductory twist Walks with 1 st elevated	Lateral heel strike Pronation Medial roll off	Foot abducted and pronating during function 1 st ray incompetence leading to toe-off via the 2 nd toe
Subject 3 (right)	Pronation Abducted foot Medial roll off Abductory twist Walks with 1 st elevated	Lateral heel strike Pronation	Foot abducted and pronating during function 1 st ray incompetence leading to toe-off via the 2 nd toe

APPENDICES

APPENDIX 1 Papers presented by podiatrists at forensic science conferences

International Association for Identification, 79th Educational Seminar, July 24 - 30, 1994, Phoenix, Arizona

DiMaggio J., "The foot and shoe: an important but overlooked identification combination,"

Gunn N., "Footwear identification proofs by pathology in leg or foot reflected into insole and outsole wear characteristics,"

Vernon D.W., "The pathologies of the foot and gait and their effect on shoe wear marks,"

International Association for Identification, 80th Educational Seminar, July 23 - 28, 1995, Costa Mesa, California

DiMaggio J., "Forensic podiatry,"

International Association for Identification, 81st Educational Seminar, July 21 - 27, 1996, Greensborough, North Carolina

Vernon D.W., "Current findings in a Delphi study of shoe wear marks,"

DiMaggio D., "Foot uniqueness and it's forensic applications: a preliminary study".

International Association for Identification, 82nd Educational Seminar, July 27 – August 1st, 1997, Boston, Massachusetts

Vernon D. W., "Towards greater understanding of the interpretation, interrelationship and variables affecting shoe wear patterns".

Canadian Identification Society Annual Conference, July 1 – 5, 1998, Kitchener, Ontario.

Vernon D. W., "Forensic podiatry "

International Association for Identification, 83rd Educational Seminar, July 19 - 25, 1998, Little Rock, Arkansas

DiMaggio J., "Does the shoe fit? A podiatrists' view"

Vernon D. W., Gunn N., "Forensic podiatry – an overview", (poster presentation)

International Association for Identification, 84th Educational Seminar, July 11 - 17, 1999, Milwaukee, Wisconsin.

DiMaggio J. "Forensic podiatry and barefoot evidence examination".

Gunn N., "The cats paw case"

Vernon D. W., "An assessment of outsole wear patterns of footwear with common ownership"

Forensic Podiatry/ Barefoot evidence Conference 2000, May 5-7, 2000, Scottsdale, Arizona

Gunn N., "A quarter century of pioneering in forensic podiatry"

Dimaggio J., "What is forensic podiatry? The basics"

Braver R., "Getting started – A new dimension in podiatry"

DiMaggio J., "The specifics of forensic podiatry – protocols, procedures and the evaluation"

Vernon W., "The shoe wear pattern project"

International Association for Identification, 85th Educational Seminar, July 23 - 29, 2000, Charleston, West Virginia.

DiMaggio J., "Barefoot evidence – the forensic podiatrists role"

APPENDIX 2 Shoe wear and its' use in diagnosis, 1979: Salford College of Technology, Northern College of Chiropody – student information sheet

SALFORD COLLEGE OF TECHNOLOGY

Northern College of Chiropody

Shoe Wear and Its use in DIAGNOSIS

Wear on a normal shoe:

1. Posterior-lateral border of the heel
2. Under the tread line of the shoe
3. Under the phalanges
4. Slight tip wear

No area of wear is excessive when compared with the rest of the shoe.

What

What are the functions of the toes?

1. To assist balance
2. To 'spring' the foot forward in walking (To 'take-off')

What will happen if the toes cease to function?

1. The foot will 'roll off the tip of the shoe' producing excessive wear.

EXCESSIVE wear on the tip of the Shoe

is caused by:

1. Loss of toe function - associated with weak foot or debility.
2. Short shoes and socks which prevent the toes from working.
3. Shoes that are too long will catch their toes on the ground.

What

What is the cause of wear on the tip of the shoe?

1. Rigid or static flat foot.

2. Hallux Valgus

Caused by the patient walking 'across' their foot to compensate for the stiffness.

Sole wear

caused by the two extremes of mobility (movement)

1. Rigidity
2. Hypermobility

N.B. They may be related to similar deformities

Rigid Flat Foot

Hypermobile Flat Foot

What differences in wear would you expect to find between Rigid and Mobile deformities?

Wear marks associated with foot strain:

Foot strain is the result of debility, or lack of power within the muscles of the leg and foot.

To compensate for this loss of power some muscles 'overpull', holding the foot in a supinated position so as to maintain the integrity of the long arch of the foot.

The result of this inversion is that the body weight is transferred to the outer border of the foot and toes resulting in wear marks in this area.

HALLUX RIGIDUS OR FLEXUS:

Similar wear marks, the above will be found with H.R. & H.F. with exaggerated wear under the HALLUX.

It will also be seen that the 'toe-spring' of the shoe will have been flattened out on the medial side to a point co-inciding with the distal end of the proximal phalanx of the HALLUX. From this point the toe will be up-turned.

PIVOTAL

This arises when the patient avoids flexing the toes in walking, or is perhaps unable to and 'swivels' off the 1st met.

concentric rings.

Wear Marks on the Heel of the Shoe

Normal wear: The wear mark on the heel corresponds with the angle of impact of the shoe.

In foot strain: causing overpull of the muscles supporting the arch the weight is displaced laterally.

The muscle supporting the arch may be able to support the 'overpull' under full weight-bearing. If they cannot, the foot will collapse onto its' medial border (usually in the severe cases of foot strain) throwing the weight onto the front of the heel.

Rigid deformities produce highly localised wear marks. Hypermobility deformities produce diffused wear marks.

If in Hypermobility the converging sides of the shoe may prevent the 1st and 5th metatarsal segments from moving forwards, the thrust on the 2nd 3rd and 4th will be exaggerated.

In extreme cases i.e. the court shoe, the thrust will be confined to the 2nd met. head only.

The foot may be elongated more along the inner than the outer border; especially if the shoe is inflated!

In these cases the wear mark under the 1st met. head will be less marked or start further forward.

The constant rubbing to and fro of the met. heads in the shoe produces a ridging of the inlay and a special type of callous formation. see Hanby & Walker. Ch. VI pp 68-71.

Wear Marks in Rigidity

A foot may be rigid in a shoe for two reasons:

1. The foot itself is rigid
2. The shoe holds the foot in a rigid position

The short shoe will also hold the foot rigid by clamping the toes in a 'clawed' position.

When the foot elongates under weight-bearing pressure is extended from both directions on the met-heads.

Both these 'types' of rigidity result in a localised wear mark, across the met-heads.

RIGIDITY OF THE FOOT

causes wear marks on the posterior border of the heel.

ABNORMAL Wear of the heel seat of the shoe:

1. If the heel seat overlaps all around the shoe, the foot is too big for the shoe.
2. Overlap of the heel seat on the inner border indicates a permanent valgus position of the foot on weight-bearing and balance.
3. Overlapping of the heel seat on the outer border indicates foot strain, the body-weight being transferred along the outer border of the foot and shoe.

Wear Marks on the upper of the shoe:

Hypermobility:

is frequently reflected in a lengthening of the medial border of the foot.

This elongation will enlarge the opening above the vamp, the contour of the opening developing an irregular shape.

If the thrust forward is very exaggerated in the hypermobile foot the head of the 1st met. will show itself on the vamp in a position anterior to normal.

This in itself is an indication of elongation of the arch and a predisposing cause of H.V.

Friction and Shearing Stress will then be set up between the foot and the shoe in two areas:

1. The medial side of the vamp.
2. Under the edge of the vamp.

The protrusion of an H.V. or a Bursa will cause creasing of the vamp of the shoe in front of the joint, causing an Hd. to form.

Therefore, Hypermobility of the foot can result in:

1. H.V.
2. Bursitis.

APPENDIX 3 Functional possibilities of the foot suggested to occur in association with hallux limitus/hallux rigidus

Functional mechanism	Author		
	Dananberg	Rzonka (1984)	Sherman (1993)
Pronation	✓ (Payne and Dananberg, 1997)		
Pronation with abduction			✓
Abducted gait		✓	
Forefoot inversion (Forefoot Varus)	✓ (Dananberg, 1986)	✓	
Supination		✓	✓
Premature lift off	✓ (Dananberg, 1986)		
Vertical toe off with secondary bipedal stance	✓ (Dananberg, 1986)	✓	
Hyperextension of 1st interphalangeal joint		✓	

✓ = function suggested by author

APPENDIX 4 Delphi round 1 package

Delphi round 1 covering letter

Podiatry and Chiropody Service

CommunityHealth Sheffield

**Fulwood House
Old Fulwood Road
Sheffield
S10 3TH
0114 - 2716767**

Dear Sir/Madam

I am a state-registered chiropodist conducting research into shoe wear patterns as part of the requirement for a M.Phil/Ph.D study at Sheffield Hallam University. I am collecting patterns of shoe wear patterns with a view to placing these on an instrument which could be used to translate the meaning of wear patterns when placed over a shoe sole outline exhibiting wear patterns. This has potential value in chiropody teaching, clinical diagnosis and in crime scene examination where worn shoe prints are found. The project is known as the SWaMP (shoe wear mark) project.

The chosen technique for collecting wear patterns is by Delphi questionnaire to pull-in information that experienced chiropodists have on causes of shoe wear patterns. Participants would be required to sketch shoe wear patterns on sole outlines on an initial questionnaire and this information would be collated and presented to participants in order to arrive at a consensus regarding shoe wear pattern causes. Participants are required who have considerable clinical knowledge and experience.

I am therefore writing to 10 heads of Trust podiatry/chiropody services and schools of podiatry to request participation in this questionnaire phase of the project. I would be grateful if you could choose a very experienced chiropodist from your staff to participate in the questionnaire rounds, giving them the enclosed explanatory notes and questionnaire to complete which can then be returned to me in the stamped, addressed envelope for collation.

Thank you for your anticipated help in this project.

Yours faithfully

D. W. Vernon
SWaMP Project Research Student
Sheffield Hallam University.

APPENDIX 4 - contd.

Delphi round 1 enclosure list

The questionnaire package contains the following :

1. Covering letter
2. Explanatory notes
3. Example sheet
4. List of structural/functional states of the foot and gait
5. Questionnaire front sheet
6. Questionnaire follow-up sheet
7. Feedback sheet
8. Stamped, addressed envelope

DWV 29/4/95

APPENDIX 4 - contd.

Delphi round 1 explanatory notes

SWaMP Project Delphi Questionnaire - Explanatory Notes

Thank you for assisting in this project by completing the questionnaire rounds involved in this technique. The purpose of this project is to determine what the current level of knowledge is of shoe wear patterns as related to the various pathological states of foot and gait. This is being evaluated as part of a M.Phil/Ph.D. research project known as the SWaMP (shoe wear mark) project at Sheffield Hallam University.

In this initial questionnaire, you are asked to sketch up to 10 wear patterns with which you are familiar on the diagrams provided. Please state the associated condition on the adjacent line. In the follow up/s, you will be shown the sum of the results of the previous round and asked whether you would wish to modify your response in light of these results. In the final round, you will be shown the summary of the round two results and asked to give your level of certainty of these results.

In this first round, please show as many wear patterns as you can up to a maximum of 10 and return the questionnaire to me in the pre-paid envelope.

A list of several structural/functional states of the foot is enclosed for your assistance along with an example sheet showing the preferred style of representing the wear marks. If you have any problems with the questionnaire, please contact me on :

Daytime - 0114 - 2716767
Evenings - 01663 - 734414







If you have any comments to make about the questionnaire, please list these on the enclosed feedback sheet.

Thank you once again for your assistance.

D. W. Vernon
SWaMP Project Research Student
Sheffield Hallam University.

APPENDIX 4 - contd.

Delphi round 1 example sheet

Associated State -----	Associated State -----	Associated State -----	Associated State -----
	<i>EXAMPLE</i>		
Associated State <u>NORMAL WEAR</u>	Associated State <u>HALLUX RIGIDUS</u>	Associated State -----	Associated State -----
			



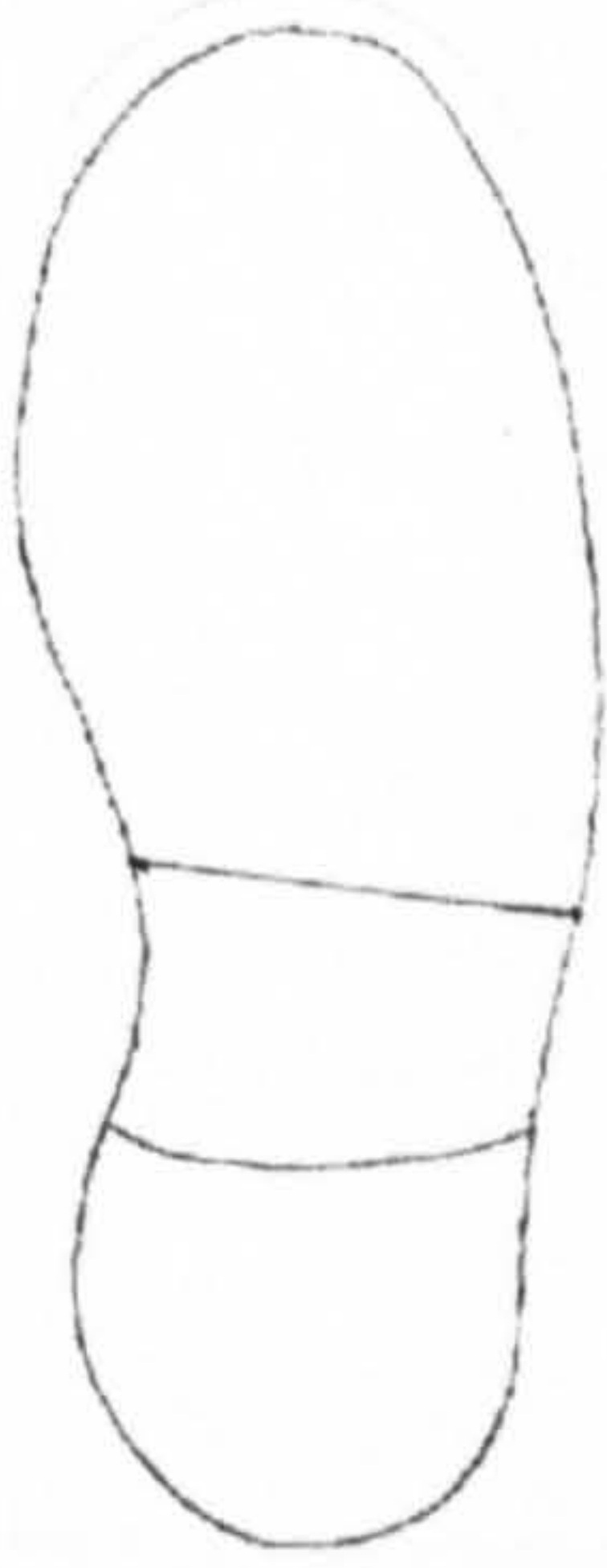





APPENDIX 4 - contd.

List of structural/functional states sent to participants

ABDUCTION	ABDUCTION AND EVERSION
ADDUCTION	ADDUCTION AND EVERSION
ANKLE EQUINUS	ATAXIC GAIT
BOW LEGS	CALCANEAL APOPHYSITIS
CALCANEAL BURSITIS	CALCANEAL EVERSION
CALCANEAL GAIT	CALCANEAL SPUR
CALCANEAL-CAVUS	CALCANEAL VALGUS
CALCANEAL-VARUS	CALCANEAL-VARUS (COMPENSATED)
CHARCOT JOINTS	CHOREA
CLAW TOES	DIGITI QUINTI VARUS
DROP FOOT	EQUINO-CAVUS
EQUINO-VARUS	EXCESSIVE ANKLE DORSIFLEXION
FOOT STRAIN	FOREFOOT VALGUS
FOREFOOT VARUS	FREIBERG'S INFRACTION
GENU VALGUM	GENU VARUM
HALLUX FLEXUS	HALLUX RIGIDUS
HALLUX VALGUS	HAMMERED 2ND TOE
HEMIPLEGIC GAIT	HIGH STEPPING GAIT
HINDFOOT VALGUS	HINDFOOT VARUS
HYPERMOBILE 1ST AND 5TH MPJTS	HYPERMOBILE FOOT
INFLARED FOOT	INTOED GAIT
KOHLERS DISEASE	LOWER MOTOR NEURONE WEAKNESS
METATARSUS ADDUCTUS	METATARSUS PRIMUS ELEVATUS
METATARSUS PRIMUS VARUS	OUT-TOED GAIT
OVERLOADED 2ND MET.	PAINFUL NAIL DISORDERS OF THE 1ST TOE
PARAPARESIS	PARAPLEGIC GAIT
PES CAVUS	PES PLANO-VALGUS
PLANTAR DIGITAL NEURITIS (MORTON'S TOE)	PLANTAR FASCIITIS
PLANTAR FLEXED 1ST AND 5TH TOES	PLANTAR FLEXED TOES
POST-OPERATIVE STATES	PRONATED FOOT
PYRAMIDAL NEUROLOGICAL DISORDERS	REDUCTION OF LONGITUDINAL AND TRANSVERSE ARCHES
RETRACTED TOES	RETRO-CALCANEAL BURSITIS
RHEUMATOID ARTHRITIS	SEVERS DISEASE
SHORT 1ST METATARSAL	SHORT 5TH METATARSAL
SHUFFLING GAIT IN PARKINSONISM	SPLAYING OF THE METATARSALS
TAYLORS BUNION	TALIPES CALCANEAL VALGUS
TALIPES CALCANEAL VARUS	TALIPES EQUINO VALGUS
TALIPES EQUINO VARUS	TARSAL ARTHRITIS
VERTICAL TALUS	WADDLING GAIT









APPENDIX 4 - contd.

Delphi round 1 questionnaire

SWaMP Questionnaire			
Name:		Tel:	
Trust address:			
Associated State -----	Associated State -----	Associated State -----	Associated State -----
			
Associated State -----	Associated State -----	Associated State -----	Associated State -----
			

APPENDIX 4 - contd.

Delphi round 1 questionnaire follow up sheet

SWaMP Questionnaire (contd.)			
Associated State -----	Associated State -----	Associated State -----	Associated State -----
			
Associated State -----	Associated State -----	Associated State -----	Associated State -----
			

APPENDIX 4 - contd.

Delphi round 1 feedback sheet

SWaMP project feedback sheet

Name of participant :




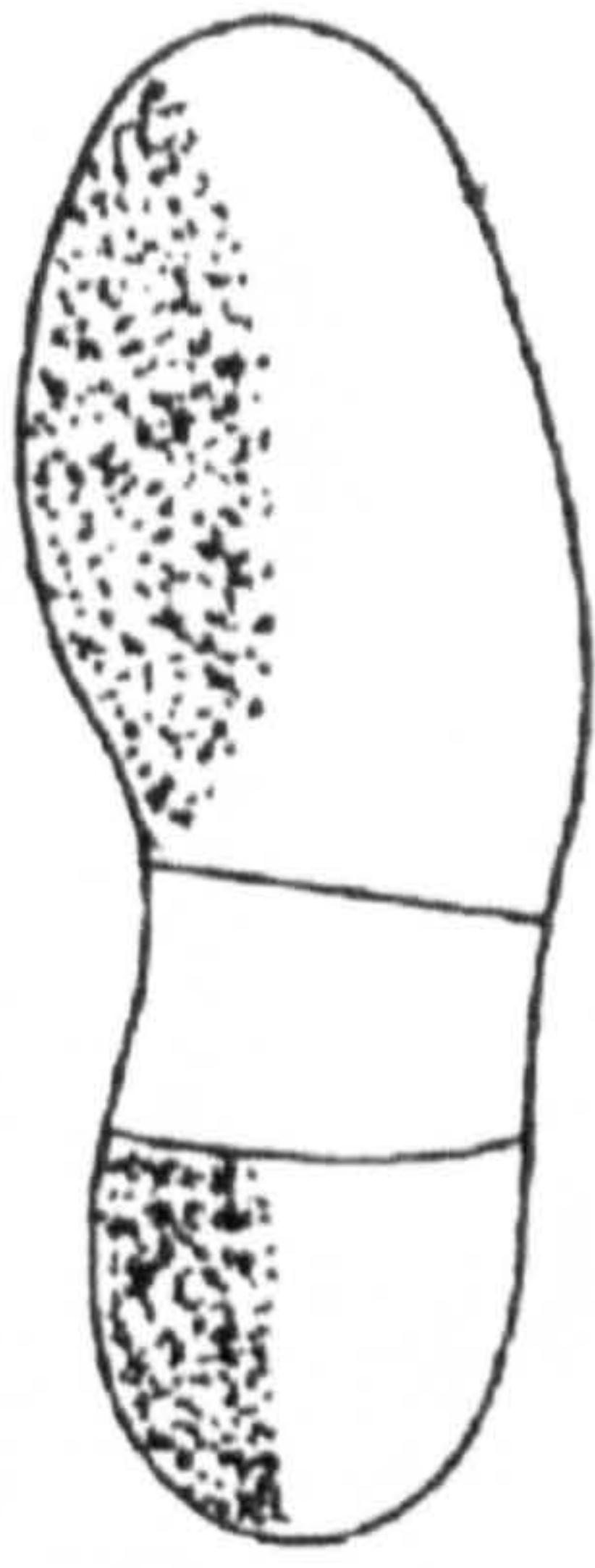
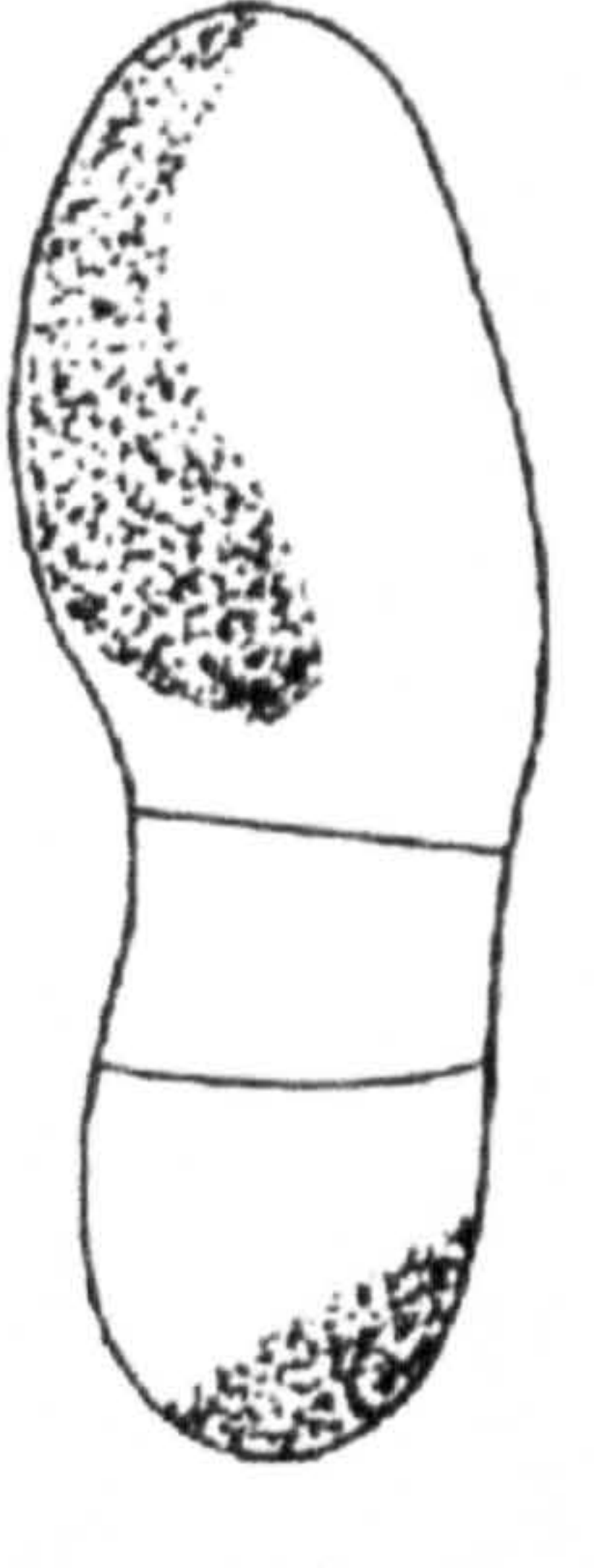


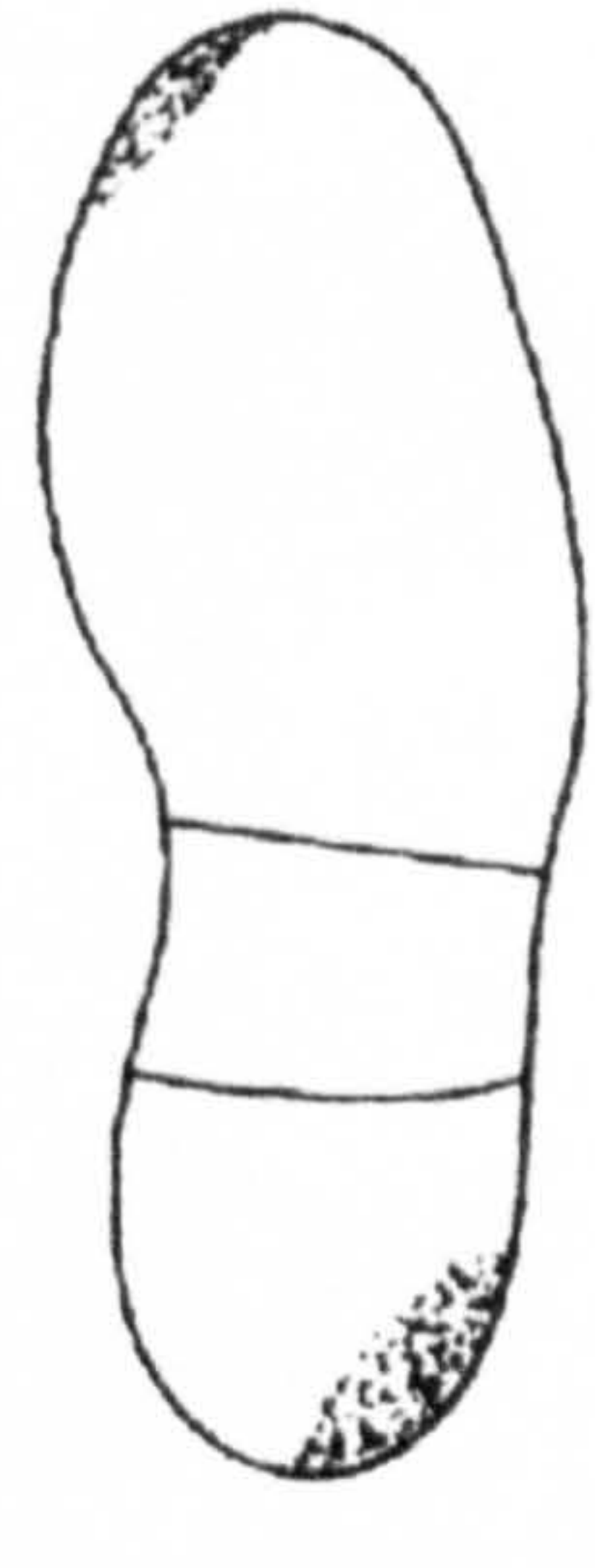

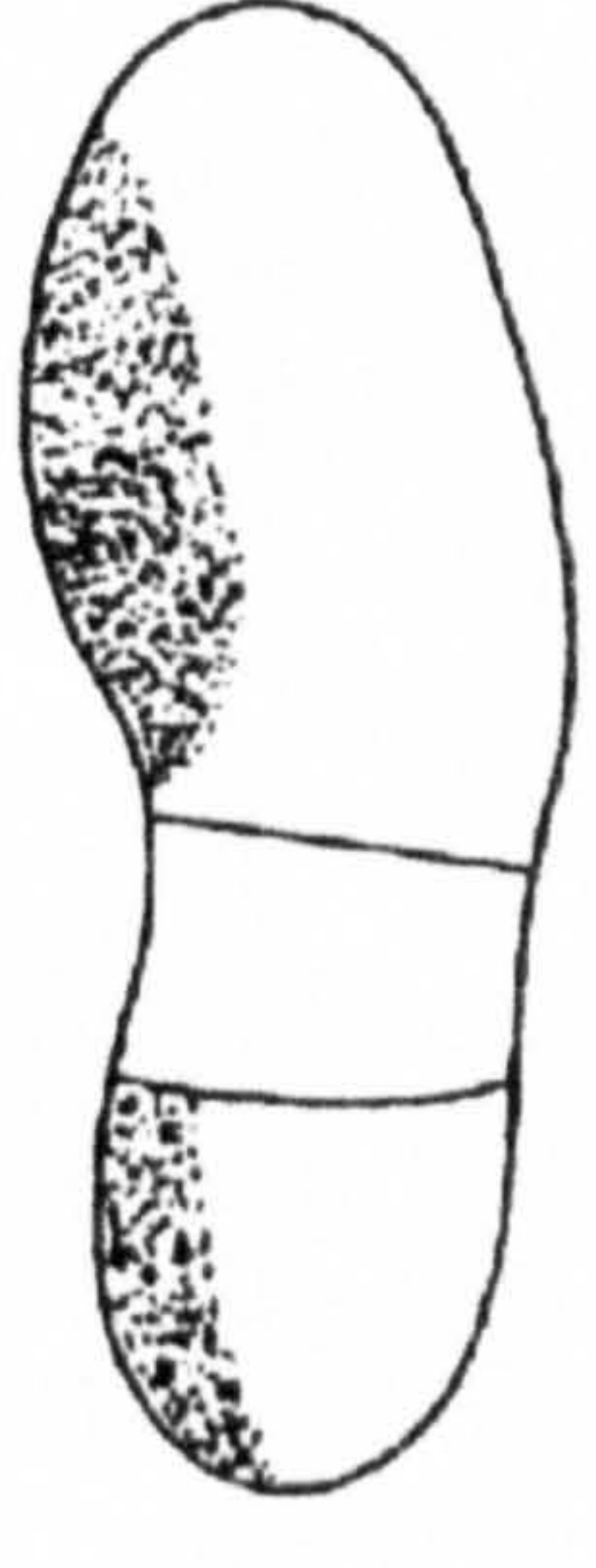


I have the following comments to make on the questionnaire :

(Please continue on separate sheet if necessary)

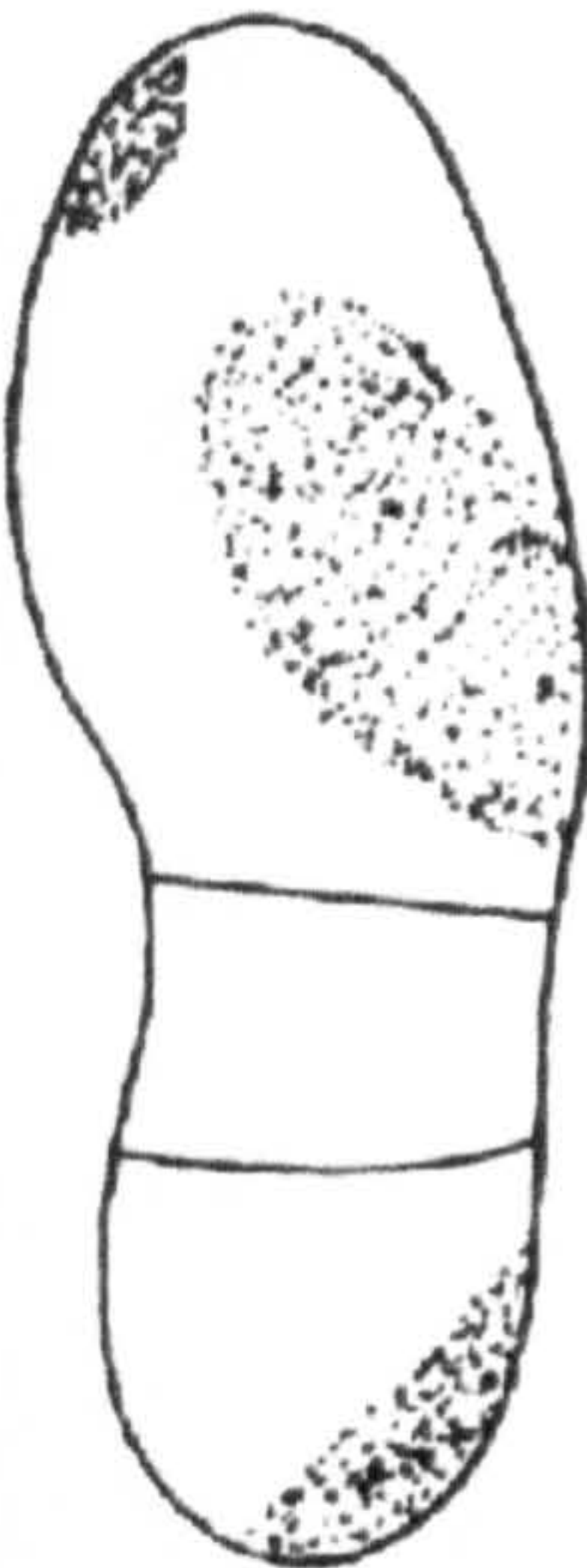
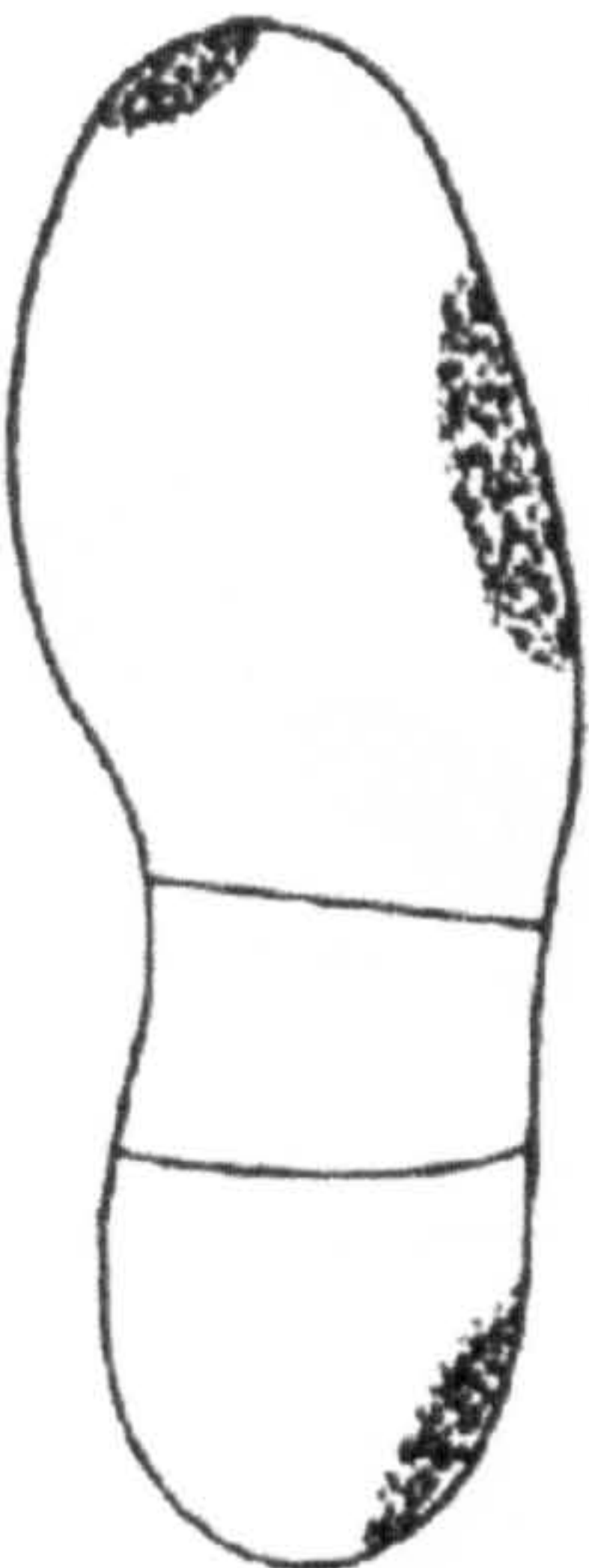
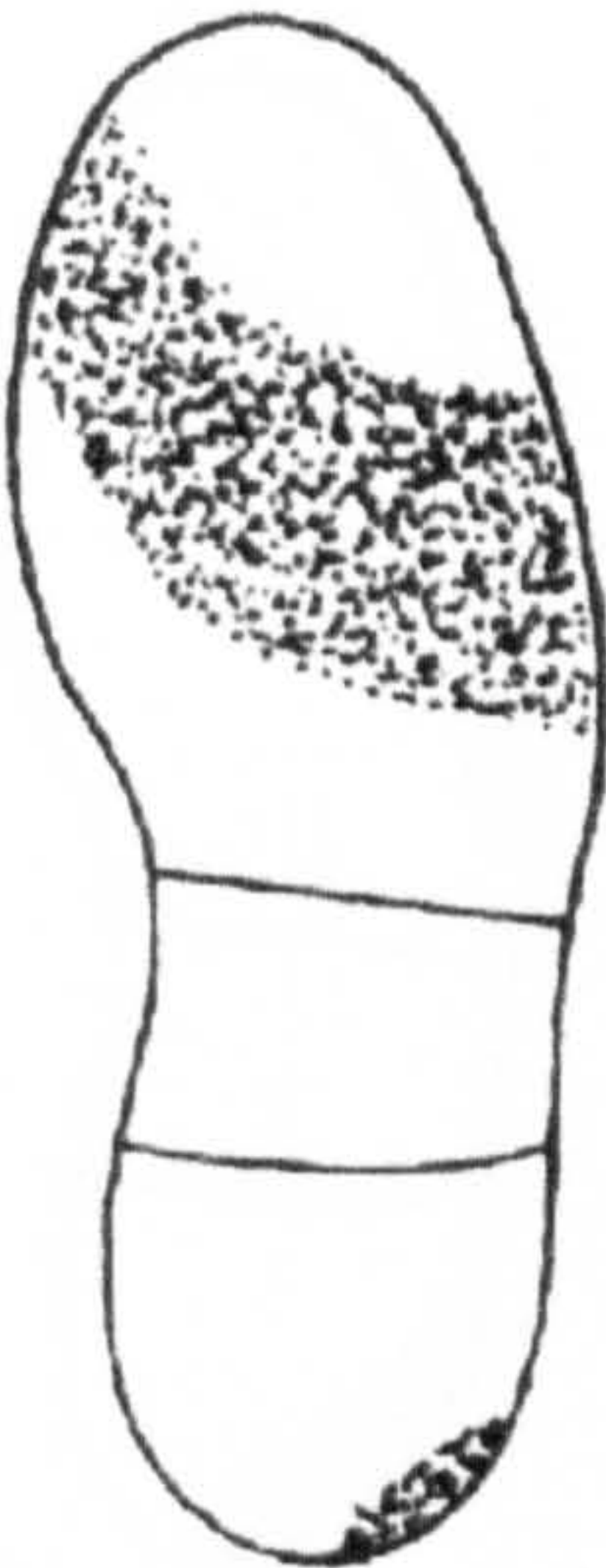

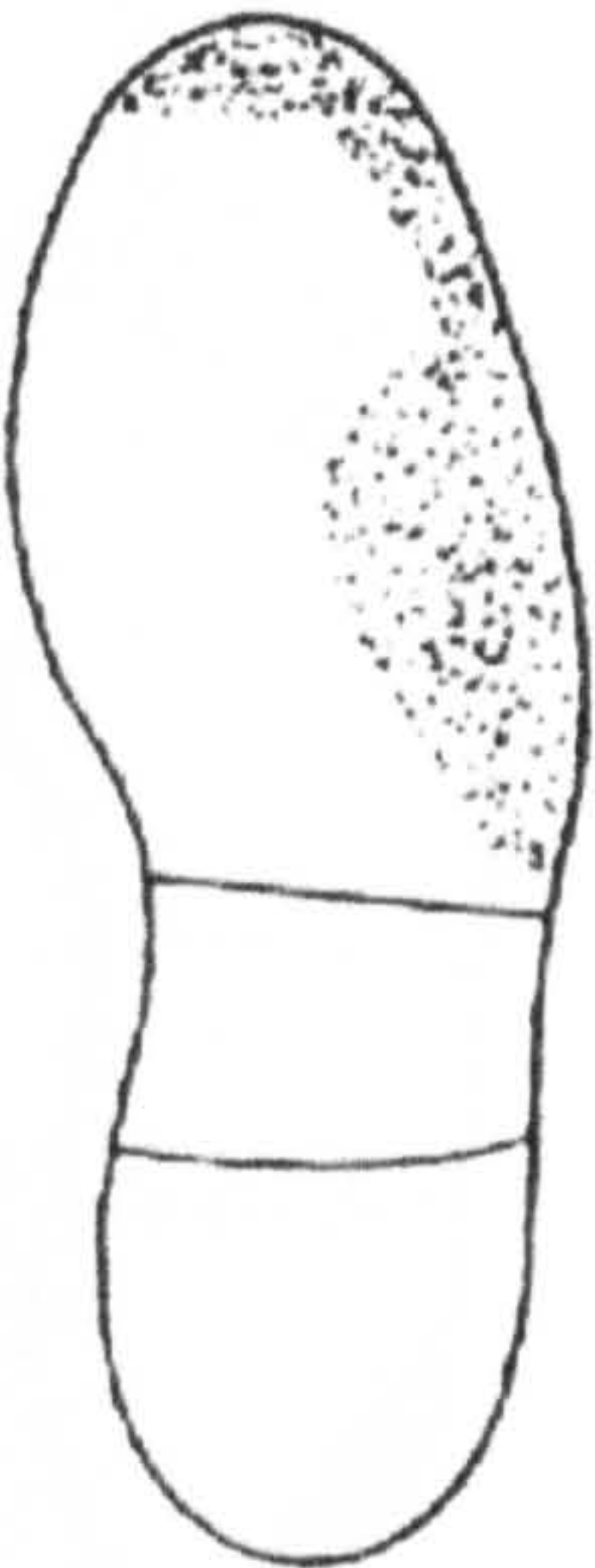
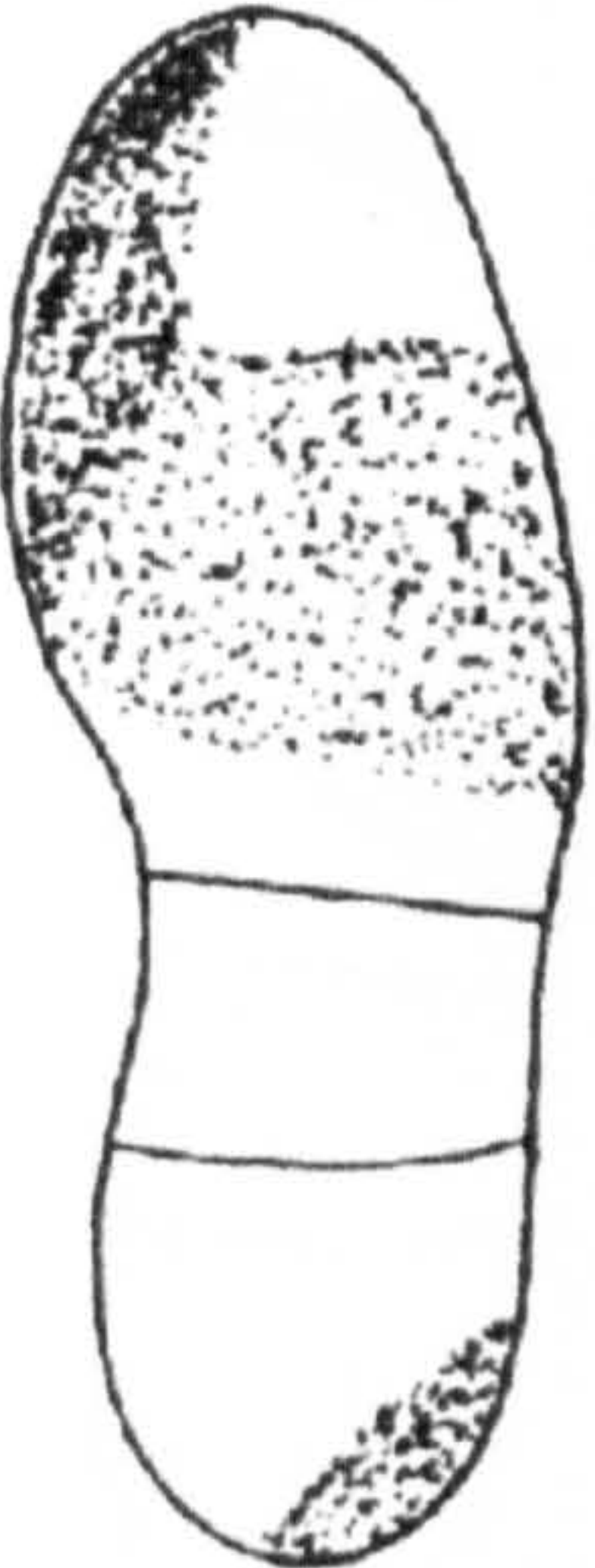

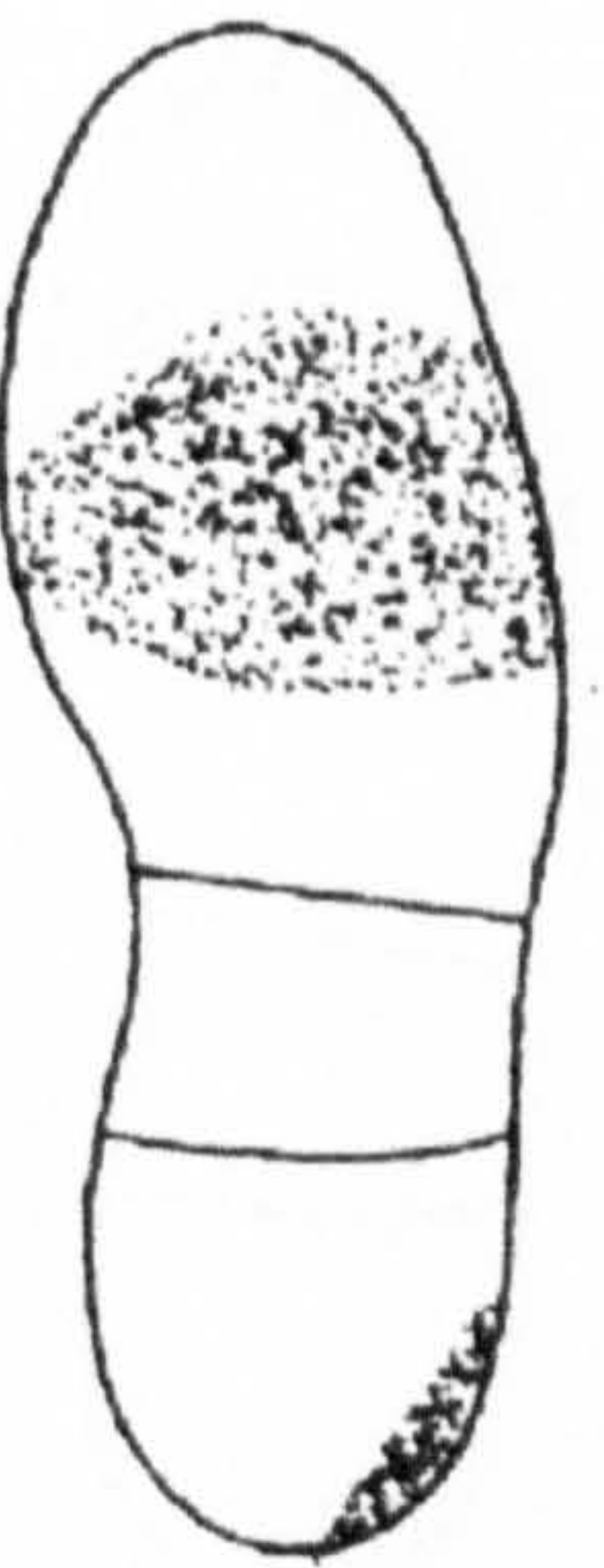
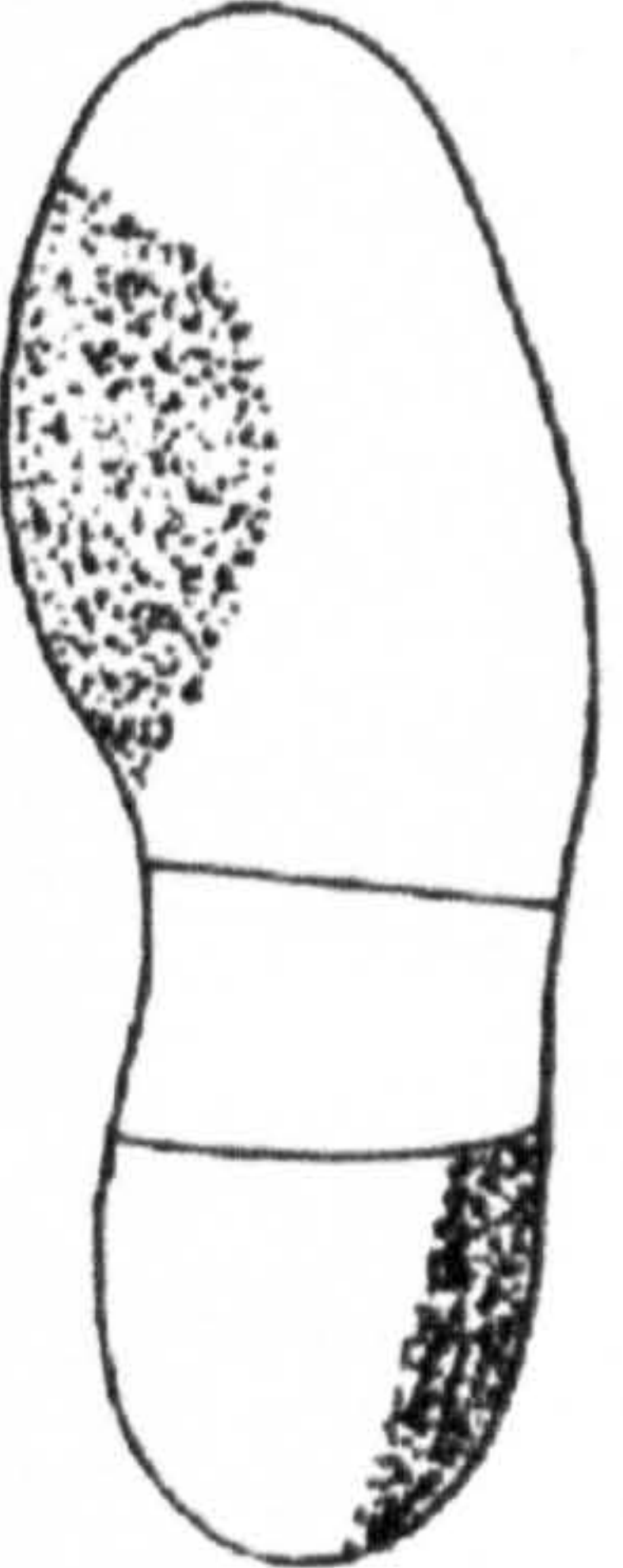
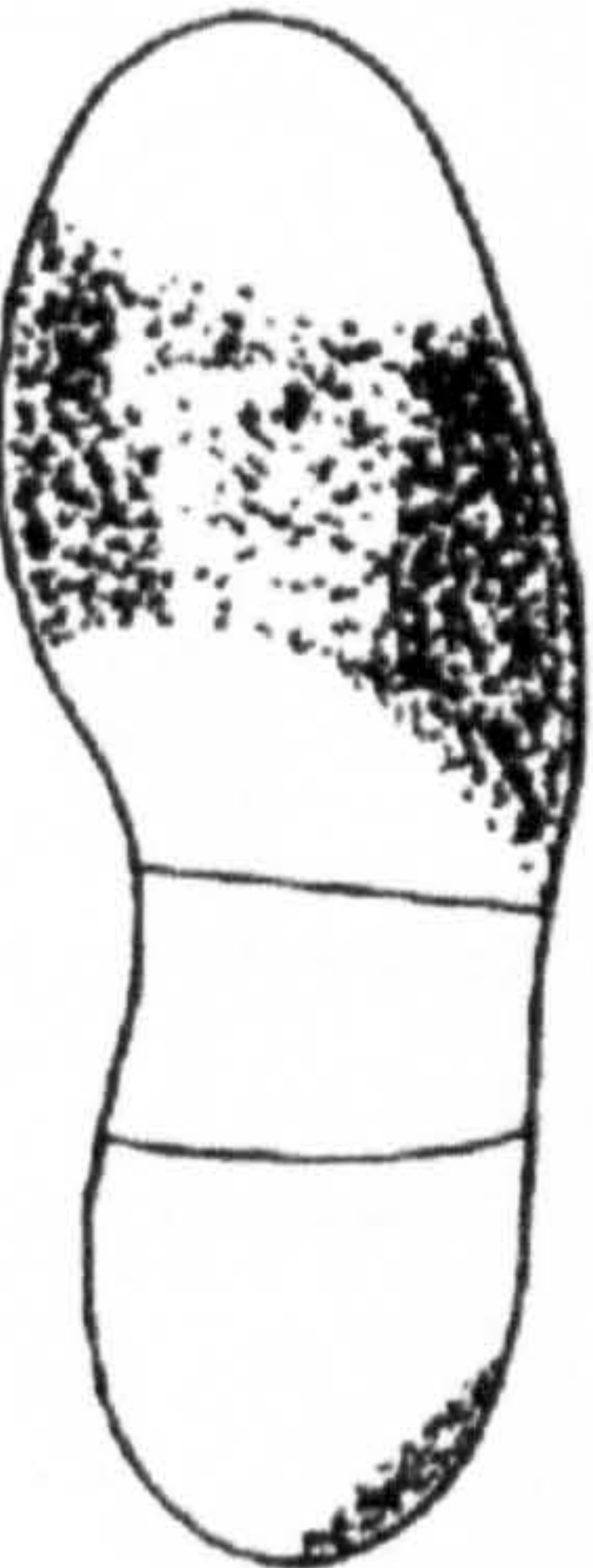
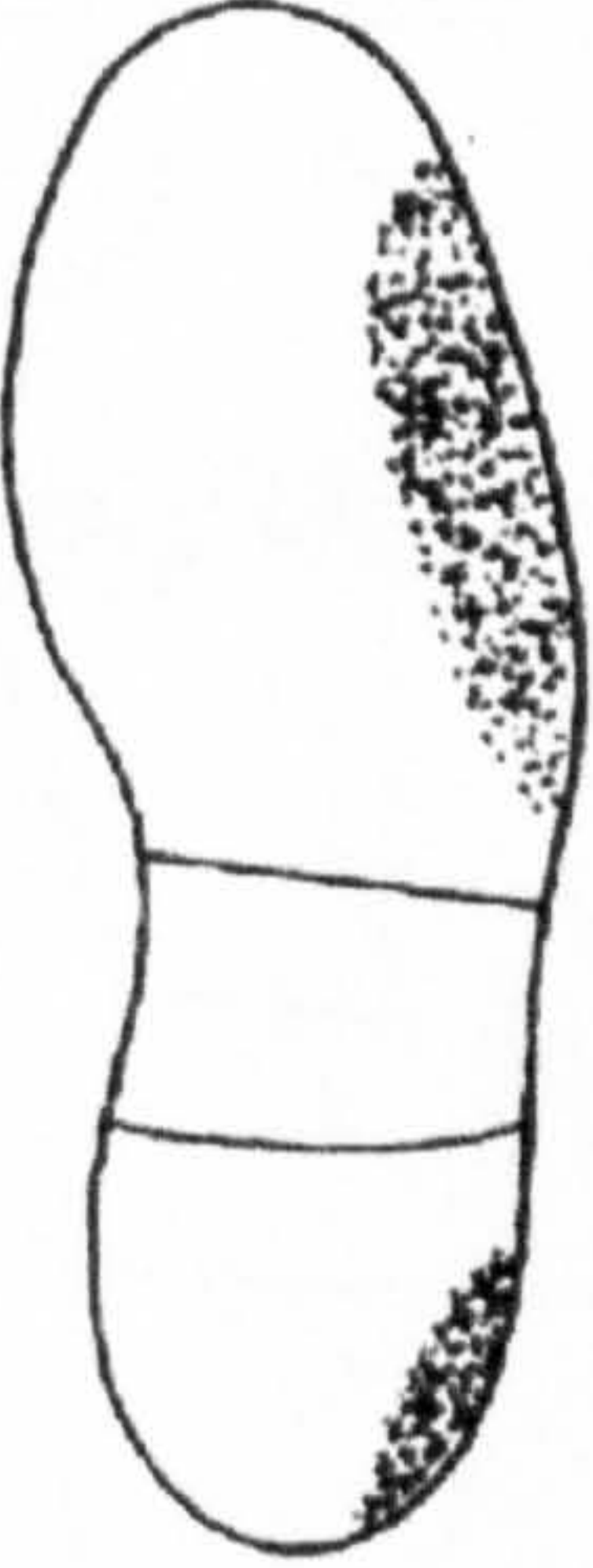

Thank you for your assistance.

D. W. Vernon
Research student
SWaMP project
Sheffield Hallam University



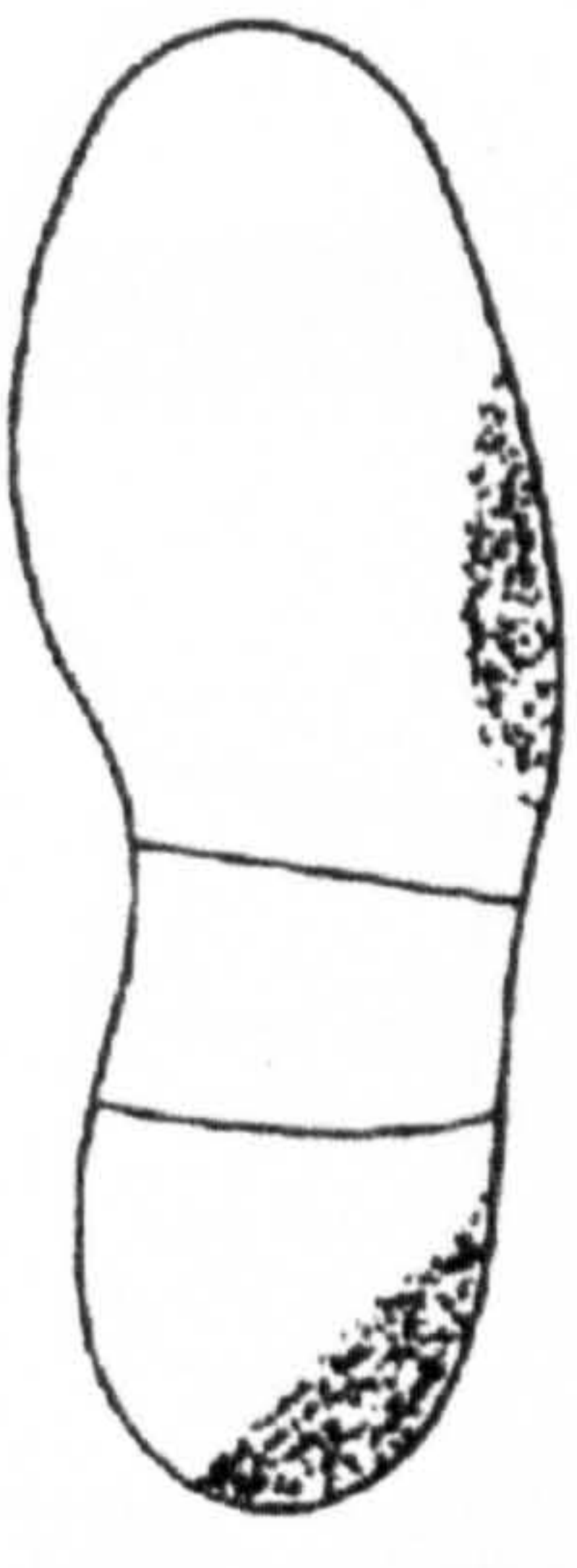



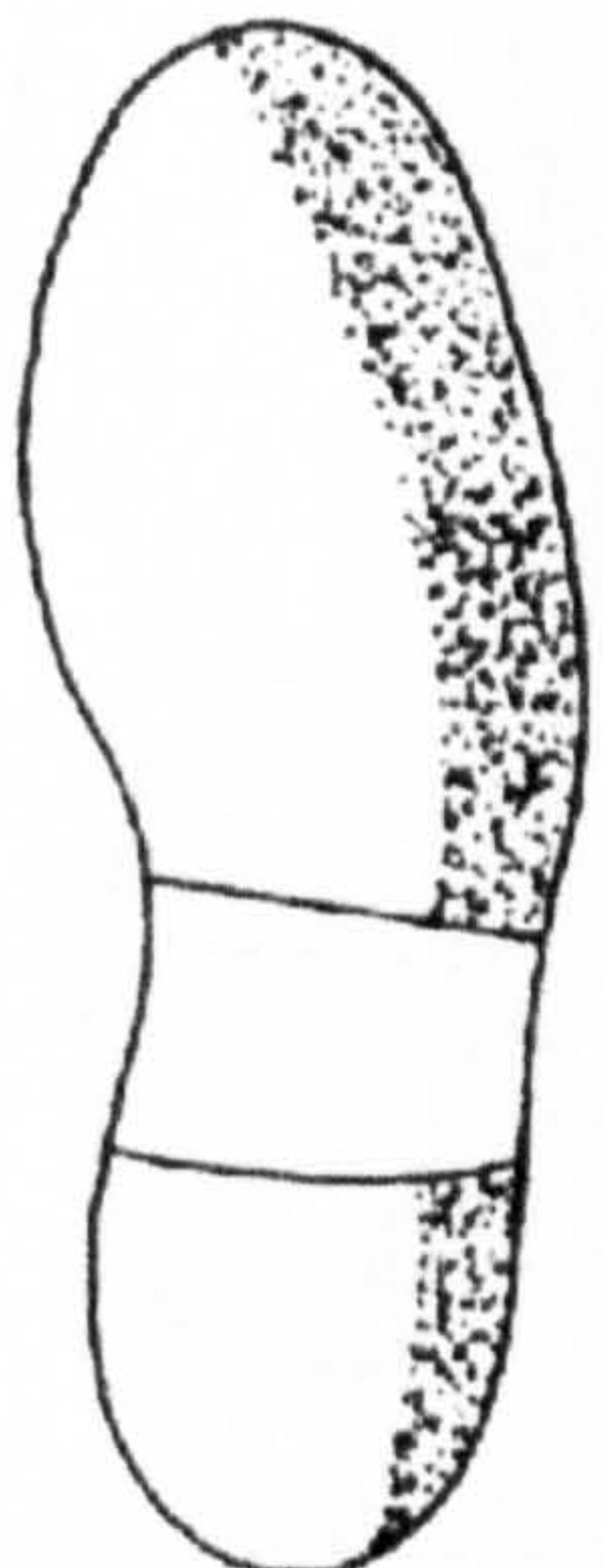

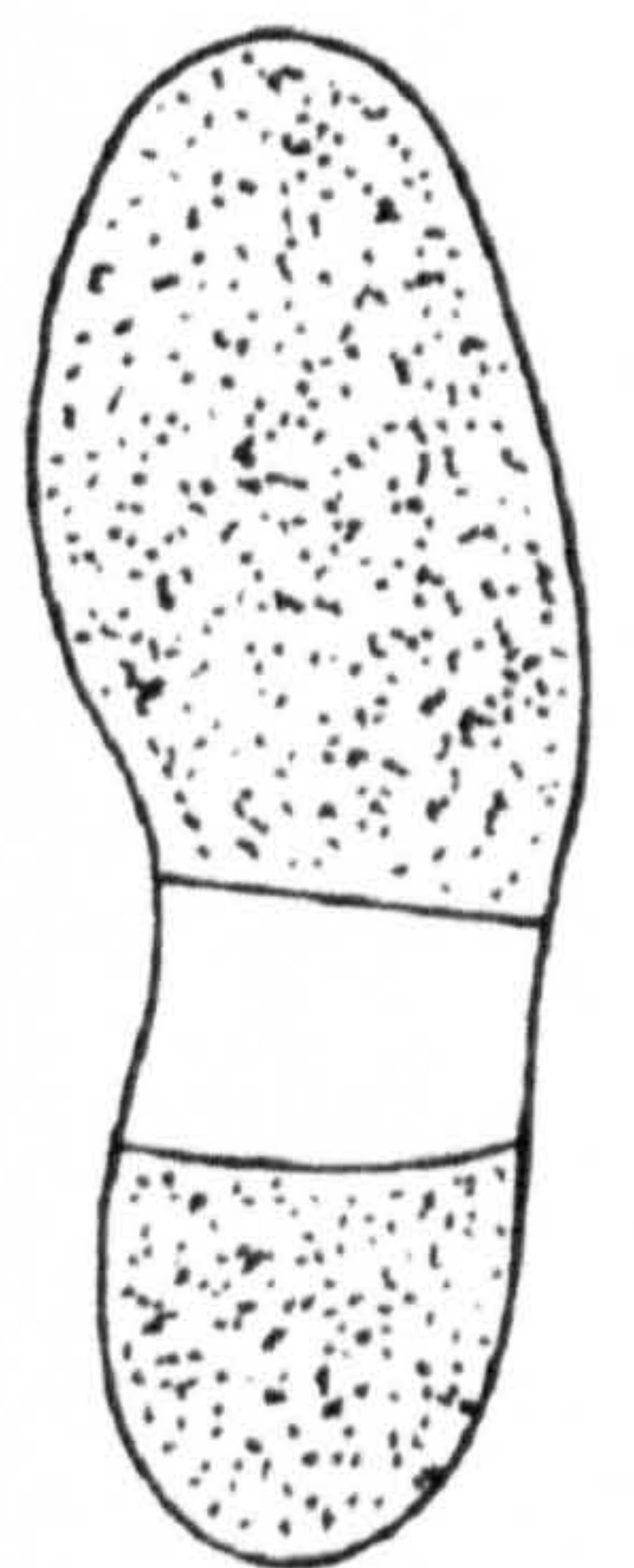


APPENDIX 5 Wear patterns for pathologies identified by more than one respondent

Calc. valgus/Pronation	Calc. valgus/Pronation	Calc. valgus/Pronation	Calc. valgus/Pronation
			
Calc. valgus/Pronation	Calc. valgus/Pronation	Calc. valgus/Pronation	Calc. valgus/Pronation
			
Calc. valgus/Pronation	Calc. valgus/Pronation	Calc. valgus/Pronation	Calc. valgus/Pronation
			

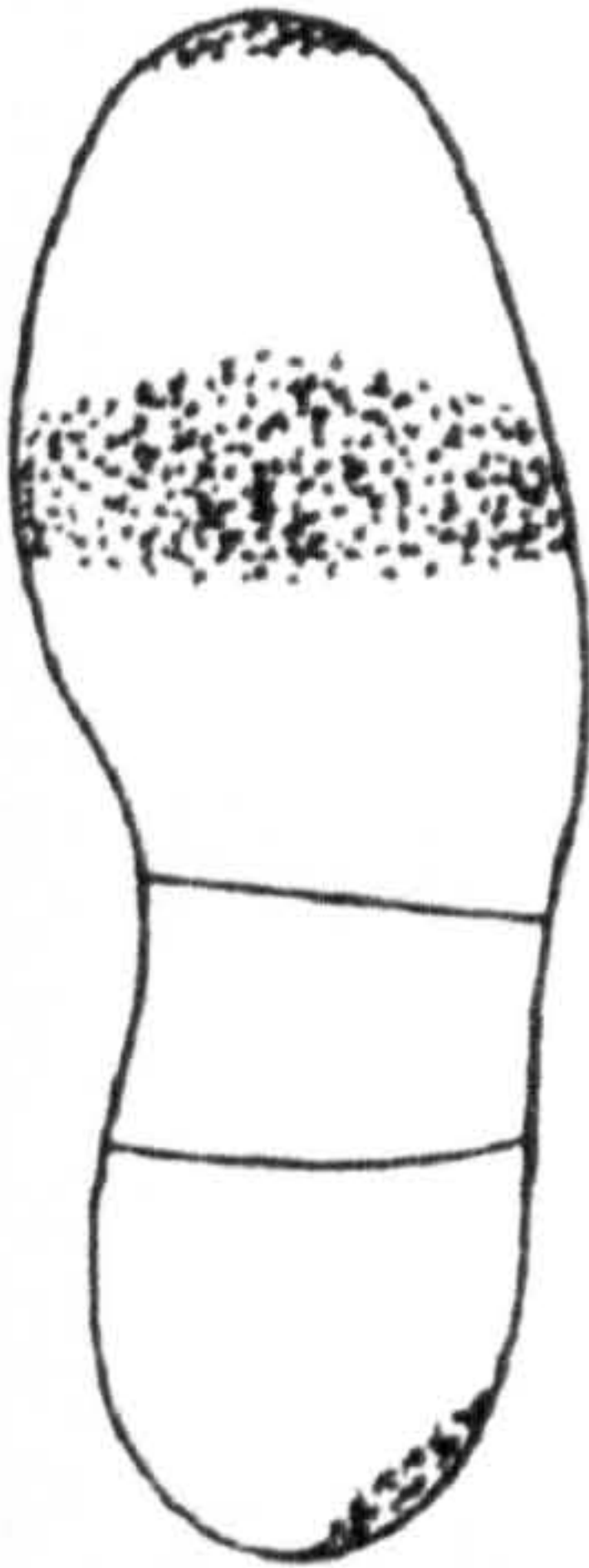



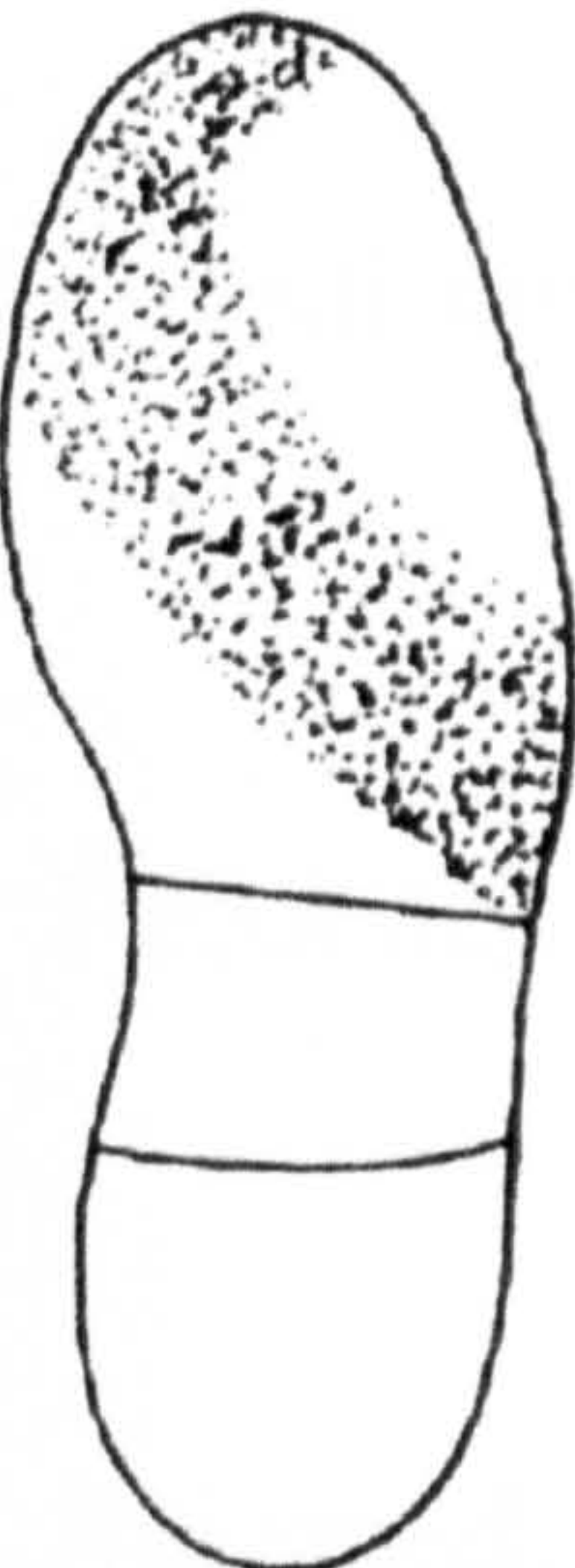



APPENDIX 5 - contd.

Hallux rigidus	Hallux rigidus	Hallux rigidus	Hallux rigidus
			
Hallux rigidus	Hallux valgus	Hallux valgus	Hallux valgus
			
Rearfoot varus	Rearfoot varus	Rearfoot varus	Rearfoot varus
			

APPENDIX 5 - contd.

Ankle equinus	Ankle equinus	Forefoot valgus	Forefoot valgus
			
Hemiplegia	Hemiplegia	Intoed gait	Intoed gait
			
Shuffling gait	Shuffling gait	Shuffling gait	
			

APPENDIX 5 - contd.

Pes cavus	Pes cavus	Retracted toes	Retracted toes
			
Severs disease	Severs disease	Talipes equino varus	Talipes equino varus
			

APPENDIX 6 Delphi Round 2 – Questionnaire package

The round 2 questionnaire package contains the following:

1. Explanatory notes
2. Key to section 2
3. Questionnaire round 2 - sections 1 and 2
4. Feedback sheet
5. Stamped, addressed envelope

DWV 24/5/95

APPENDIX 6 – contd.

Questionnaire round two - explanatory notes

Thank you for completing round one of the questionnaire. The purpose of round one was to collect a maximum of 10 characteristic shoe wear mark patterns from each participant. The results of the questionnaire have been collated and consensus is now sought in round two over a number of the patterns given. There are two sections in round two which you are asked to complete.

In section one, a characteristic wear mark pattern given by round one participants is shown. You are asked to indicate which of the given conditions that this wear mark relates to. You may mark as many possibilities as you wish for each condition.

In section two, a number of characteristic patterns given by round one participants have been broken down into separate wear area components. The percentage of replies given for each named condition which indicated wear in that area is shown along with the actual number of respondents that this percentage represents. You are asked to indicate which of these wear components you agree with in order to make up a total wear pattern. You may amend the response you gave in round one if you wish to do so. A key to section two is enclosed for your reference.

I would be grateful if you could respond within three weeks of receipt of this round two. As in the first round, if you have any comments regarding the second round, please list these on the enclosed feedback sheet.

If you have any problems with the questionnaire, please contact me on :

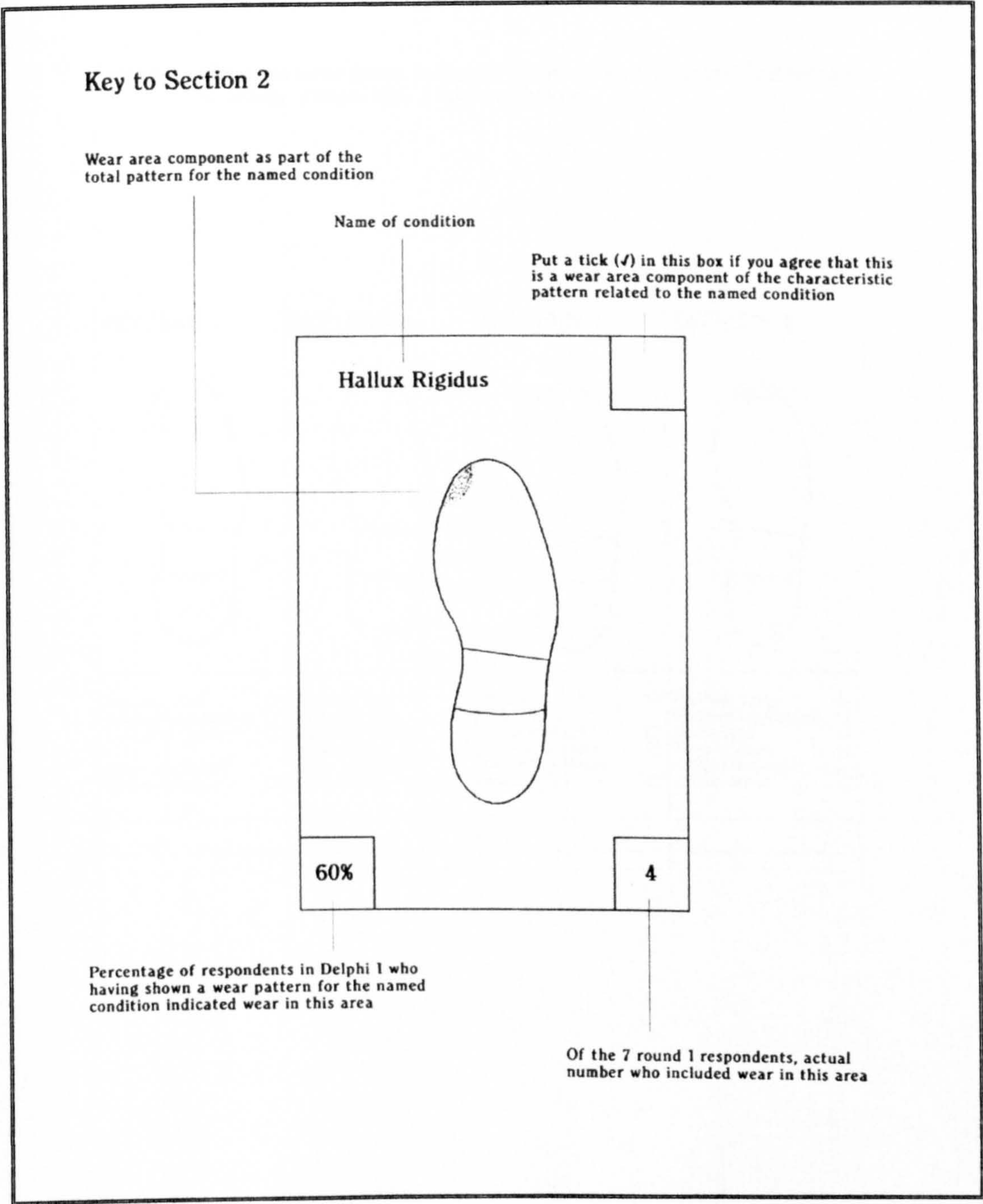
Daytime - 0114 - 2716767
Evenings - 01663 - 734414

Thank you once again for your assistance.

W. Vernon
SWaMP Project Research Student
Sheffield Hallam University.





APPENDIX 6 – contd.

Round 2, section 2 key



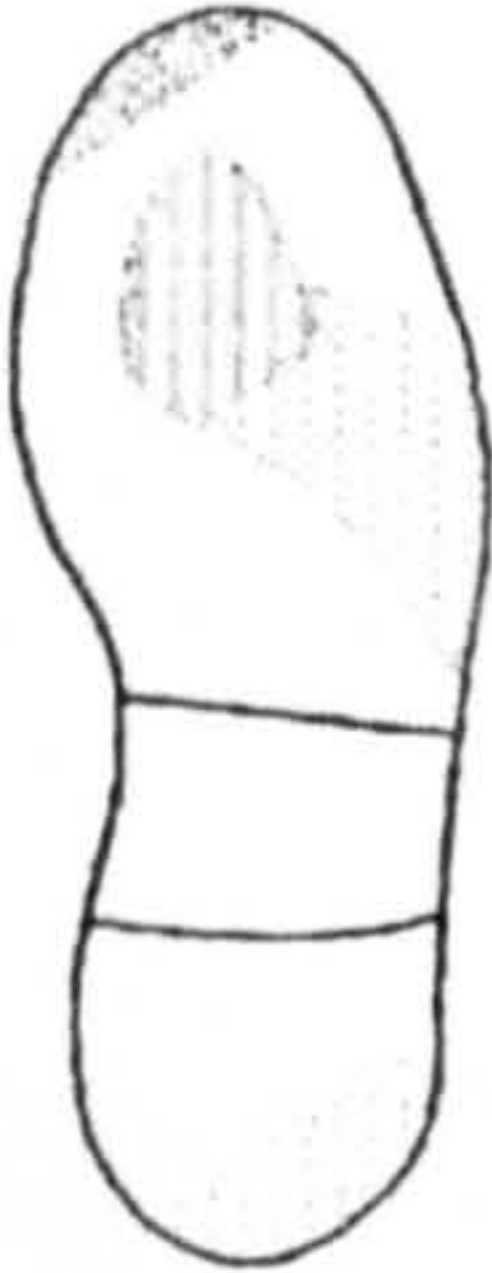
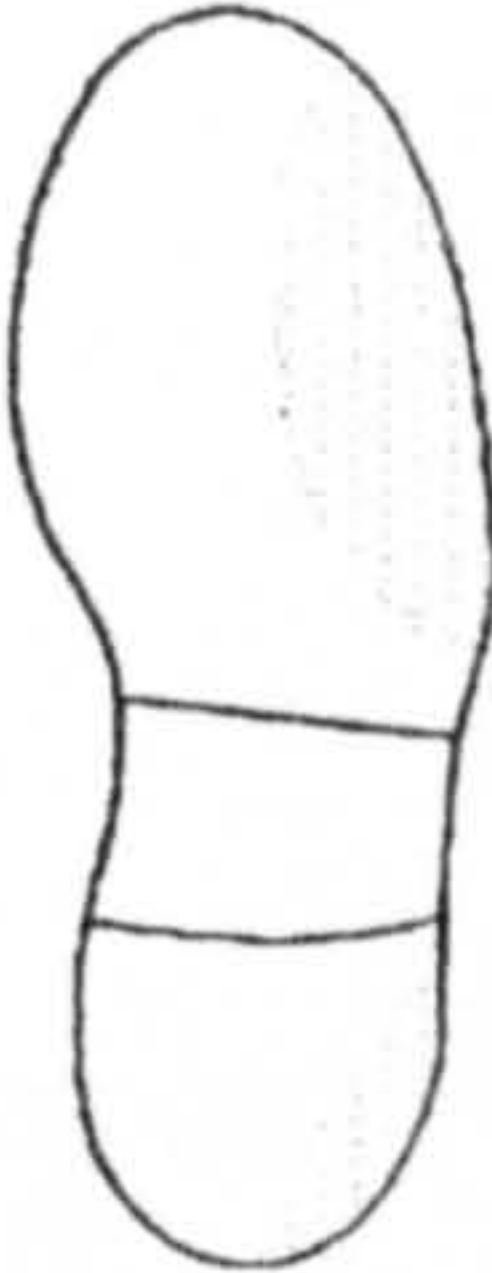

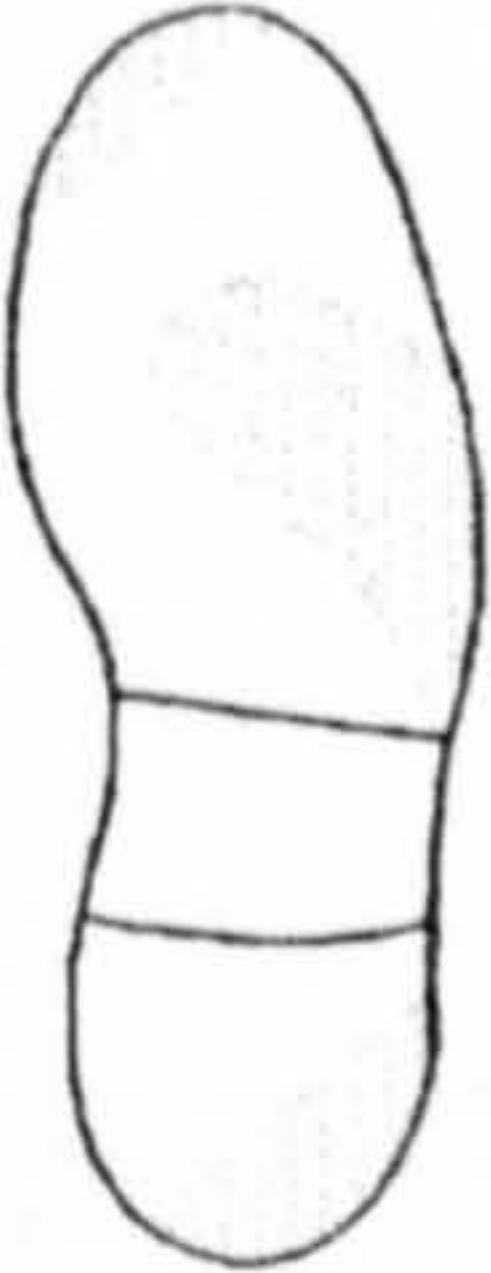
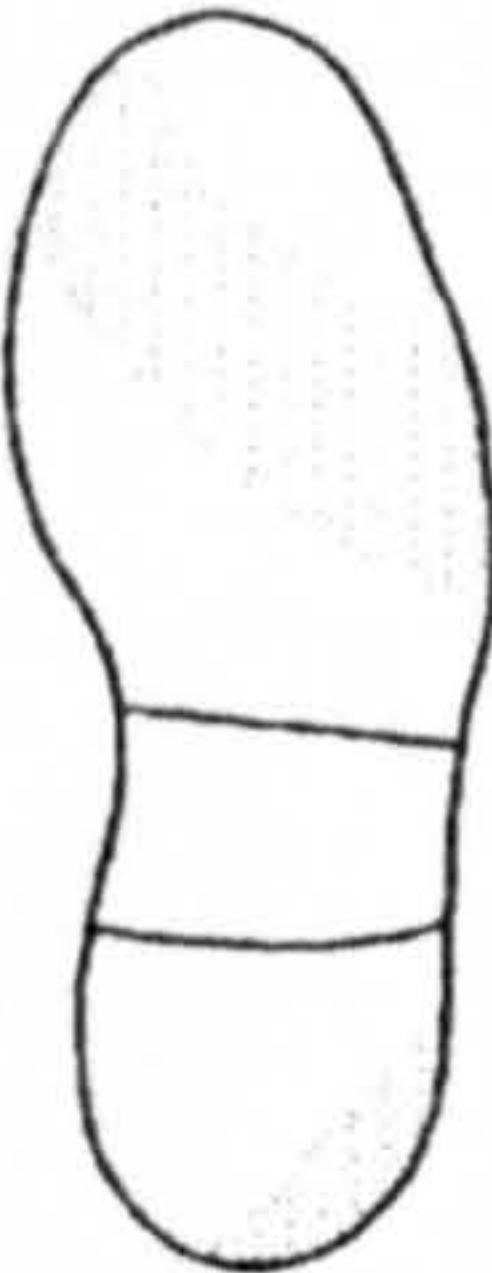

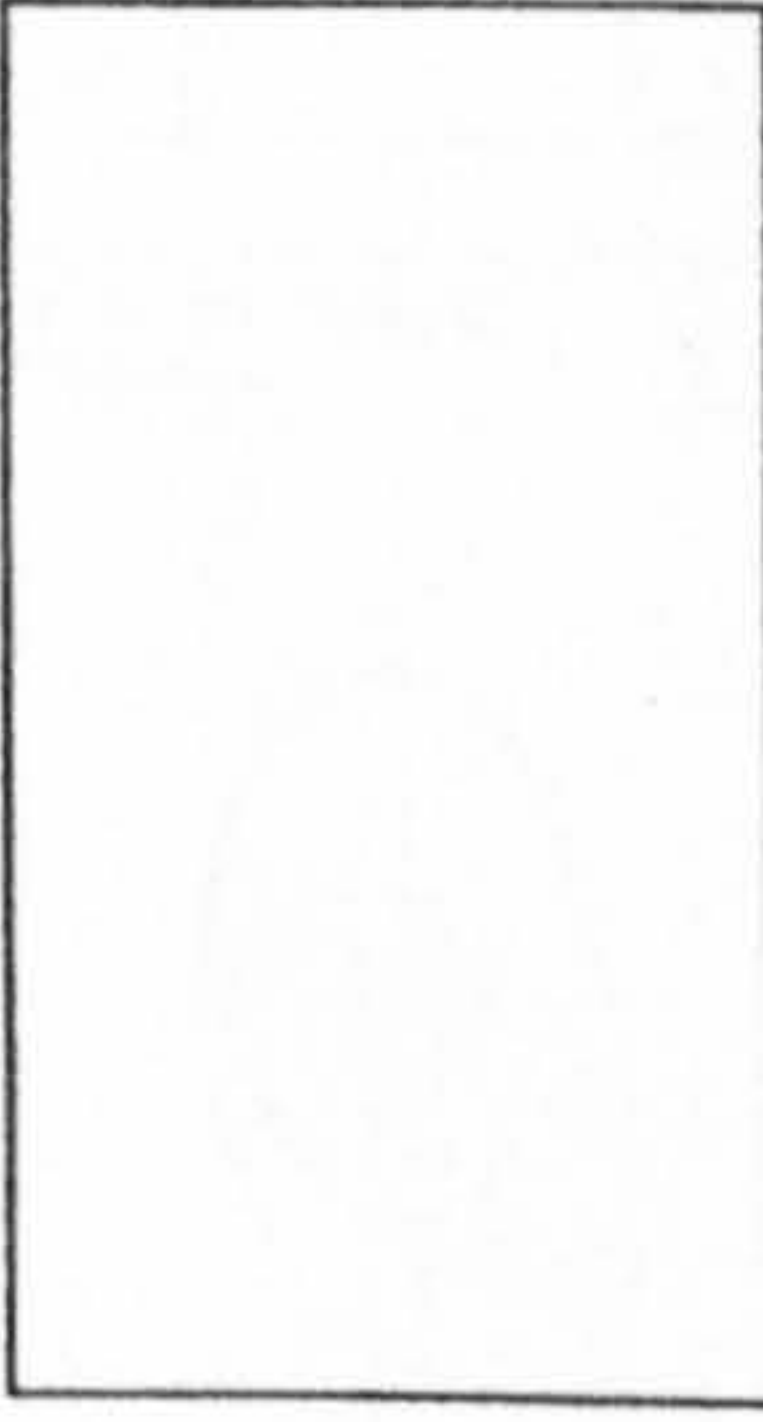

Delphi round 2, section 1a

Section 1. Wear patterns given in Round 1 under more than one 'pathology' heading. Please tick ✓ relevant boxes.

PATTERN 1.	PATTERN 2.	PATTERN 3.	PATTERN 4.
			
<div>Pronated Foot <input type="checkbox"/></div> <div>Metatarsus Adductus <input type="checkbox"/></div> <div>Neither of these <input type="checkbox"/></div> <div>Other condition/s (please state) <input type="checkbox"/></div> <div>.....</div> <div>.....</div>	<div>Pronated Foot <input type="checkbox"/></div> <div>Retracted Toes <input type="checkbox"/></div> <div>Forefoot Valgus <input type="checkbox"/></div> <div>None of these <input type="checkbox"/></div> <div>Other condition/s (please state) <input type="checkbox"/></div> <div>.....</div> <div>.....</div>	<div>Pronated Foot <input type="checkbox"/></div> <div>Calc. Varus (compensated) <input type="checkbox"/></div> <div>Neither of these <input type="checkbox"/></div> <div>Other condition/s (please state) <input type="checkbox"/></div> <div>.....</div> <div>.....</div>	<div>Forefoot Varus <input type="checkbox"/></div> <div>Freiberg's Infraction <input type="checkbox"/></div> <div>Hemiplegia <input type="checkbox"/></div> <div>None of these <input type="checkbox"/></div> <div>Other condition/s (please state) <input type="checkbox"/></div> <div>.....</div> <div>.....</div>









Delphi round 2, section 1b

Section 1 (continued)

<p>PATTERN 5.</p>  <p>Hammer 2nd toe <input type="checkbox"/> Claw toes <input type="checkbox"/> Neither of these <input type="checkbox"/> Other condition/s (please state) <input type="checkbox"/></p>	<p>PATTERN 6.</p>  <p>Talipes Equino Varus <input type="checkbox"/> Rearfoot Varus <input type="checkbox"/> Neither of these <input type="checkbox"/> Other condition/s (please state) <input type="checkbox"/></p>	<p>PATTERN 7.</p>  <p>Ankle Equinus <input type="checkbox"/> Severs disease <input type="checkbox"/> Neither of these <input type="checkbox"/> Other condition/s (please state) <input type="checkbox"/></p>	<p>PATTERN 8.</p>  <p>Pes Cavus <input type="checkbox"/> Hallux Rigidus <input type="checkbox"/> Neither of these <input type="checkbox"/> Other condition/s (please state) <input type="checkbox"/></p>
<p>PATTERN 9.</p>  <p>Hallux Rigidus <input type="checkbox"/> Short 1st Metatarsal <input type="checkbox"/> Neither of these <input type="checkbox"/> Other condition/s (please state) <input type="checkbox"/></p>	<p>PATTERN 10.</p>  <p>Hallux Rigidus <input type="checkbox"/> Rearfoot Valgus <input type="checkbox"/> Neither of these <input type="checkbox"/> Other condition/s (please state) <input type="checkbox"/></p>	<p>PATTERN 11.</p>  <p><input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/></p>	<p>PATTERN 12.</p>  <p><input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/></p>

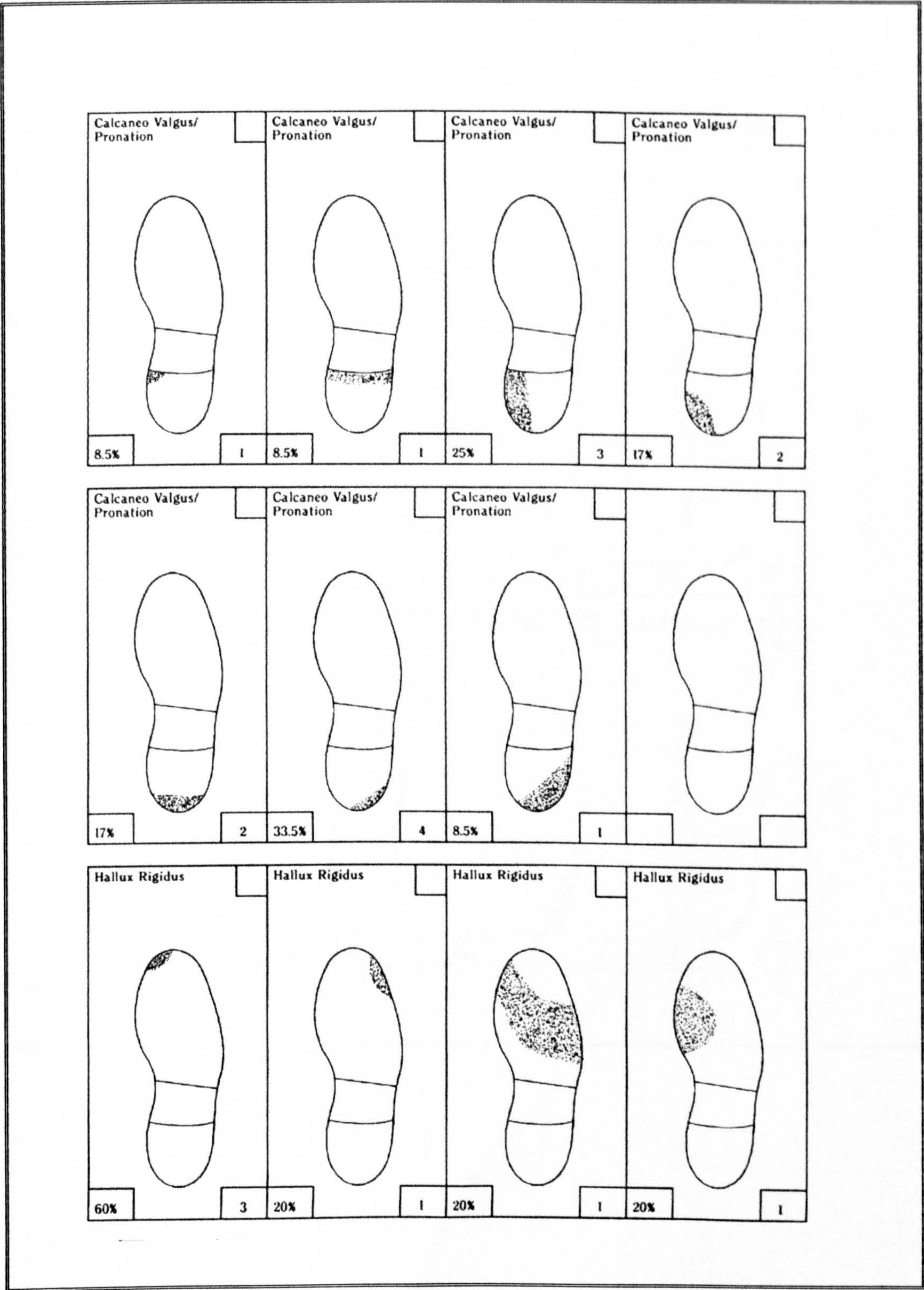
Delphi round 2, section 2a

Possible wear area components which make up a total characteristic wear pattern for named pathologies are indicated. Please tick those with which you are in agreement.
(See Key for explanation).

Calcaneo Valgus/ Pronation		25%	<input type="checkbox"/>	3	8.5%	<input type="checkbox"/>	1	8.5%	<input type="checkbox"/>	1	8.5%	<input type="checkbox"/>	1
Calcaneo Valgus/ Pronation			<input type="checkbox"/>			<input type="checkbox"/>			<input type="checkbox"/>			<input type="checkbox"/>	
Calcaneo Valgus/ Pronation			<input type="checkbox"/>			<input type="checkbox"/>			<input type="checkbox"/>			<input type="checkbox"/>	
Calcaneo Valgus/ Pronation			<input type="checkbox"/>			<input type="checkbox"/>			<input type="checkbox"/>			<input type="checkbox"/>	
Calcaneo Valgus/ Pronation		33.5%	<input type="checkbox"/>	4	17%	<input type="checkbox"/>	2	8.5%	<input type="checkbox"/>	1	17%	<input type="checkbox"/>	2
Calcaneo Valgus/ Pronation			<input type="checkbox"/>			<input type="checkbox"/>			<input type="checkbox"/>			<input type="checkbox"/>	
Calcaneo Valgus/ Pronation			<input type="checkbox"/>			<input type="checkbox"/>			<input type="checkbox"/>			<input type="checkbox"/>	
Calcaneo Valgus/ Pronation			<input type="checkbox"/>			<input type="checkbox"/>			<input type="checkbox"/>			<input type="checkbox"/>	

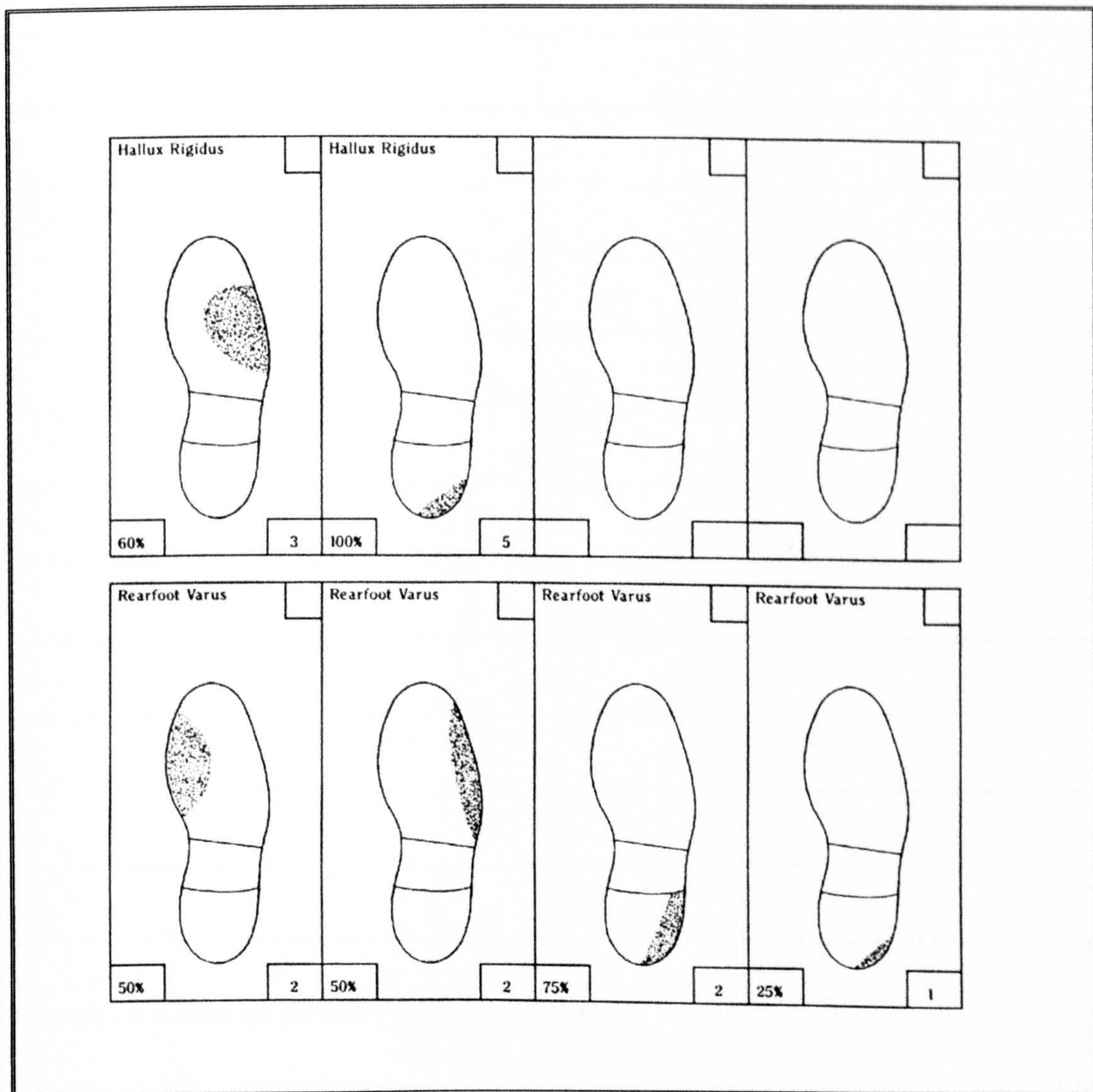
APPENDIX 6 – contd.

Delphi round 2, section 2b



APPENDIX 6 – contd.

Delphi round 2, section 2c



APPENDIX 6 – contd.

Round 2 feedback sheet

Name of participant :

I have the following comments to make on round 2 :

(Please continue on separate sheet if necessary)

Thank you for your assistance.

D. W. Vernon
SWaMP project research student
Sheffield Hallam University

APPENDIX 7 Delphi round 3 questionnaire package

The SWaMP round 3 questionnaire package contains the following :

1. Explanatory notes
2. Example sheet/key to Section 1
3. Example sheet/key to Section 2
4. Questionnaire Round 3 - Sections 1 and 2
5. Feedback sheet
6. Stamped, addressed envelope

DWV 27/3/96

APPENDIX 7 – contd.

Explanatory notes

SWaMP Project Round 3 - Explanatory Notes

The results of the SWaMP Round two questionnaire have now been collated and analysed. Round three is now presented and again consists of two sections.

In **Section 1**, the patterns which you commented on in Round two are shown along with the percentage of responses given for each possible associated condition.

In **Section 2**, the pattern components for named conditions which you commented on in Round 2 are shown along with the percentage of responses given for each component.

Please study these sections carefully and tick the response or responses that you are in agreement with. If you wish to amend your response in light of these results, please do so. If you wish to mark a response that represents a minority viewpoint (i.e. one that had less than 30% agreement), please briefly state your justification for this, continuing on a separate sheet if necessary. Finally, would you please mark with crosses the points from which you believe wear to be spreading on each pattern.

A key/example sheet for each section is enclosed for your reference.

I would be grateful if you could respond within three weeks of receipt of this round three. As in previous rounds, if you have any comments regarding this round, please list these on the enclosed feedback sheet.

If you have any problems with the questionnaire, please contact me on :

Daytime - 0114 - 2716767
Evenings - 01663 - 734414

Thank you once again for your assistance.

D.W. Vernon
SWaMP Project Research Student
Sheffield Hallam University.

APPENDIX 7 – contd.

Section 1 example sheet

SWaMP Questionnaire Round 3

Key/example to Section 1

Diagram of a foot showing wear patterns. The forefoot area is shaded with a stippled pattern and contains five 'X' marks. The heel area is also shaded and contains one 'X' mark. A line points from the text 'Pattern depicted' to the shaded forefoot area. Another line points from the text '(X = Focal point(s) from which the wear is spreading)' to one of the 'X' marks in the forefoot.

Levels of agreement in Round 2

Retracted Toes	85%	<input type="checkbox"/>
Forefoot Valgus	41%	<input type="checkbox"/>
Pronated foot	14%	<input type="checkbox"/>
<hr/> <hr/> <hr/> <hr/> <hr/>		

Suggested causes of pattern

Tick here if in agreement and cross any possibilities that you would dispute strongly

Space for minority view justification

Section 2 example sheet

SWaMP Questionnaire Round 3

Key/example to Section 2

Condition for which wear
pattern component is
depicted

Hallux Rigidus

18

Pattern number



Pattern component depicted

(X = Focal point(s) from which
the wear is spreading)

Percentage in
agreement in
Round 2

85%





Tick here if in agreement
and place a cross here if
you dispute this strongly

Space for minority
view justification

Section 1

SWaMP Questionnaire Round 3 Section 1




This section shows wear patterns given in Round 1 under more than one 'pathology' heading which you commented on in Section 1 of the last Round. Please consider each pattern again in light of the percentage agreement seen in this last round and tick (✓) the conditions with which you are in agreement. You may alter your response from that given in the last Round. If you wish to express a minority viewpoint (i.e. support a condition for which there has been less than 30% of participants in agreement), please give a brief justification/explanation of your belief. If there are any possible responses with which you are in strong disagreement, please mark these with a cross (X). On the diagram, will you please mark (X) the focal points from which you believe the wear to be spreading.



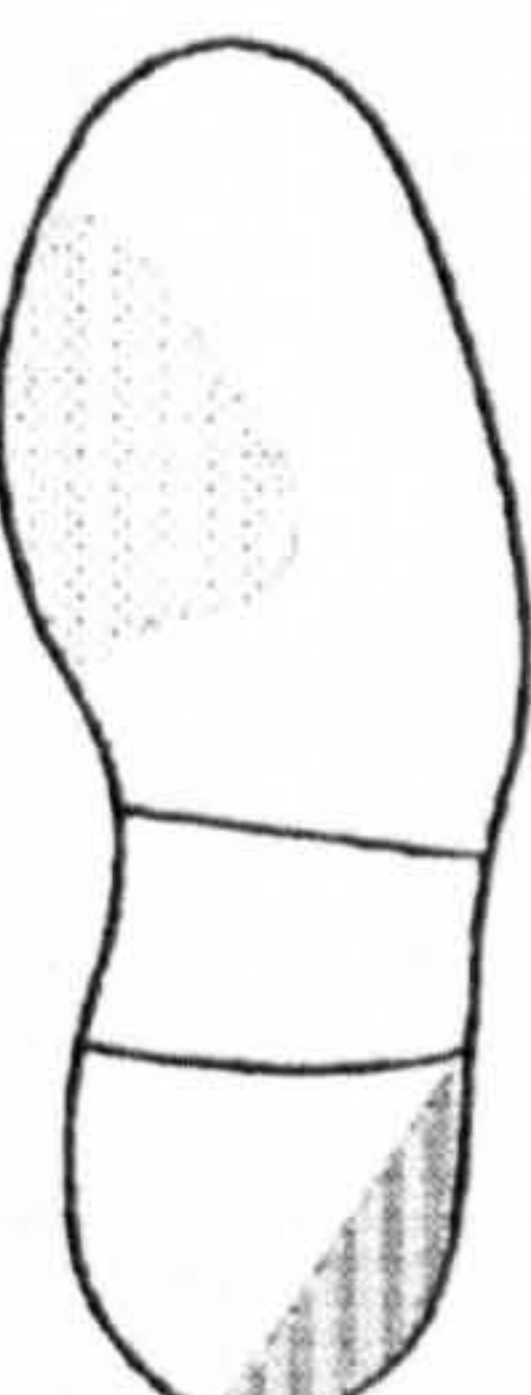
PATTERN 1			PATTERN 2			PATTERN 3			PATTERN 4		
											
Pronated foot	75%		Pronated foot	12%		Pronated foot	37%		Freibergs Infraction	12%	
Metatarsus Adductus	12%		Retracted toes	87%		Compensated Calcaneo Varus	50%		Hemiplegia	87%	
Calcaneo Varus	12%		Forefoot Valgus	37%		Hallux Rigidus	12%				
						Hallux Valgus	12%				
						Ankle Equinus	12%				
.....				
.....				
.....				

APPENDIX 7 – contd.

Section 1 (contd.)

SWaMP Questionnaire Round 3 Section 1 (contd.)





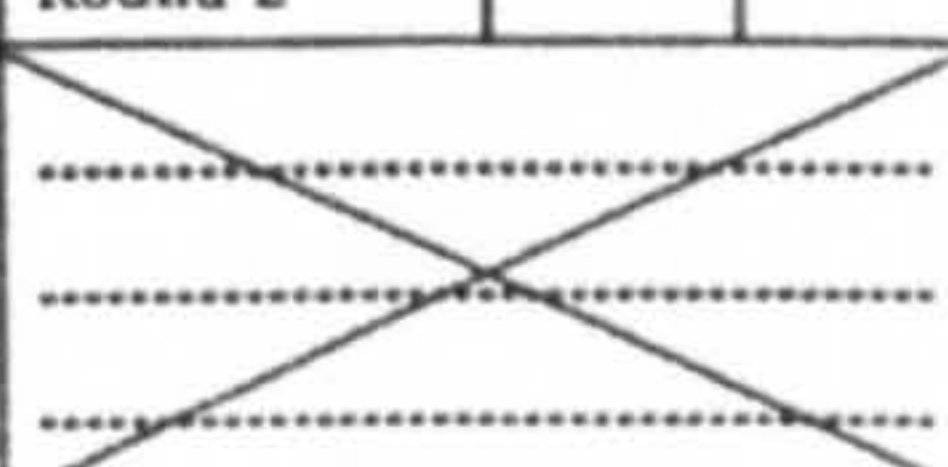
PATTERN 5			PATTERN 6			PATTERN 7		
								
Hammer 2nd toe	75%		Talipes Equino Varus	50%		Ankle Equinus	75%	
Claw toes	25%		Calcaneo Varus	50%		Severs Disease	12%	
Pes Cavus	12%		Hemiplegia	12%				
.....				
.....				
.....				

PATTERN 8			PATTERN 9			PATTERN 10		
								
Pes Cavus	37%		Hallux Rigidus	75%		Hallux Rigidus	12%	
Hallux Rigidus	75%		Short 1st Metatarsal	25%		Calcaneo Valgus	37%	
						Forefoot Varus	12%	
						Calcaneo Varus	12%	
						Normal Foot	12%	
.....				
.....				
.....				

Section 2





SWaMP Questionnaire Round 3 Section 2





This section shows components of wear patterns given in Round 1 Section 2 which you commented on in the last Round. Please consider each pattern again in light of the percentage agreement seen in this last round and tick (✓) the pattern components which you are in agreement with. You may alter your response from that given in the last Round. If you wish to express a minority viewpoint (i.e. support a pattern component for which there has been less than 30% of the participants in agreement), please give a brief justification/explanation of your belief. If there are any possible responses with which you are in strong disagreement, please mark these with a cross (✗). Those components in boxes crossed through have achieved either 100% or 0% agreement and do not require an answer, but are provided for your reference only. On the diagram, will you please mark (X) the focal points from which you believe the wear to be spreading.

Calcaneo Valgus/Pronation		1	Calcaneo Valgus/Pronation		2	Calcaneo Valgus/Pronation		3	Calcaneo Valgus/Pronation		4
											
Percentage in agreement in Round 2	25%		Percentage in agreement in Round 2	0%		Percentage in agreement in Round 2	12%		Percentage in agreement in Round 2	37%	
.....							
.....				
.....				

Section 2 (contd.)

SWaMP Questionnaire Round 3 Section 2 (contd.)





Calcaneo Valgus/Pronation 5	Calcaneo Valgus/Pronation 6	Calcaneo Valgus/Pronation 7	Calcaneo Valgus/Pronation 8				
							
Percentage in agreement in Round 2	100%	Percentage in agreement in Round 2	25%	Percentage in agreement in Round 2	0%	Percentage in agreement in Round 2	12%
<div></div> <div></div> <div></div>		<div></div> <div></div> <div></div>		<div></div> <div></div> <div></div>		<div></div> <div></div> <div></div>	





Calcaneo Valgus/Pronation 9	Calcaneo Valgus/Pronation 10	Calcaneo Valgus/Pronation 11	Calcaneo Valgus/Pronation 12				
							
Percentage in agreement in Round 2	12%	Percentage in agreement in Round 2	0%	Percentage in agreement in Round 2	50%	Percentage in agreement in Round 2	37%
<div></div> <div></div> <div></div>		<div></div> <div></div> <div></div>		<div></div> <div></div> <div></div>		<div></div> <div></div> <div></div>	

APPENDIX 7 – contd.

Section 2 (contd.)

SWaMP Questionnaire Round 3 Section 2 (contd.)


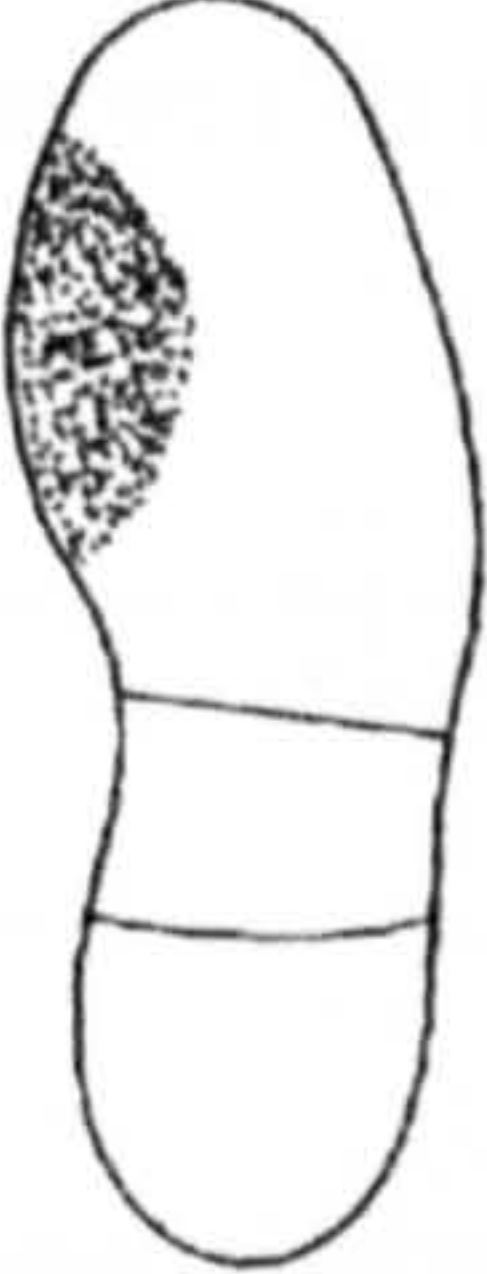


Calcaneo Valgus/Pronation		13	Calcaneo Valgus/Pronation		14	Calcaneo Valgus/Pronation		15	Hallux Rigidus		16
											
Percentage in agreement in Round 2	25%		Percentage in agreement in Round 2	37%		Percentage in agreement in Round 2	50%		Percentage in agreement in Round 2	62%	
.....				
.....				
.....				


Hallux Rigidus		17	Hallux Rigidus		18	Hallux Rigidus		19	Hallux Rigidus		20
											
Percentage in agreement in Round 2	12%		Percentage in agreement in Round 2	62%		Percentage in agreement in Round 2	0%		Percentage in agreement in Round 2	62%	
.....				
.....				
.....				

APPENDIX 7 – contd.

Section 2 (contd.)

SWaMP Questionnaire Round 3 Section 2 (contd.)

Hallux Rigidus	21	Rearfoot Varus	22	Rearfoot Varus	23	Rearfoot Varus	24
							
Percentage in agreement in Round 2	75%	Percentage in agreement in Round 2	50%	Percentage in agreement in Round 2	62%	Percentage in agreement in Round 2	100%
.....		
.....		
.....		

Rearfoot Varus	25				
					
Percentage in agreement in Round 2	12%	Percentage in agreement in Round 2	%	Percentage in agreement in Round 2	%
.....		
.....		
.....		

Feedback sheet

SWaMP Project round 3 feedback sheet

Name of participant :

I have the following comments to make on round three :

(Please continue on separate sheet if necessary)

Thank you for your assistance.

D. W. Vernon
Research student
SWaMP project
Sheffield Hallam University

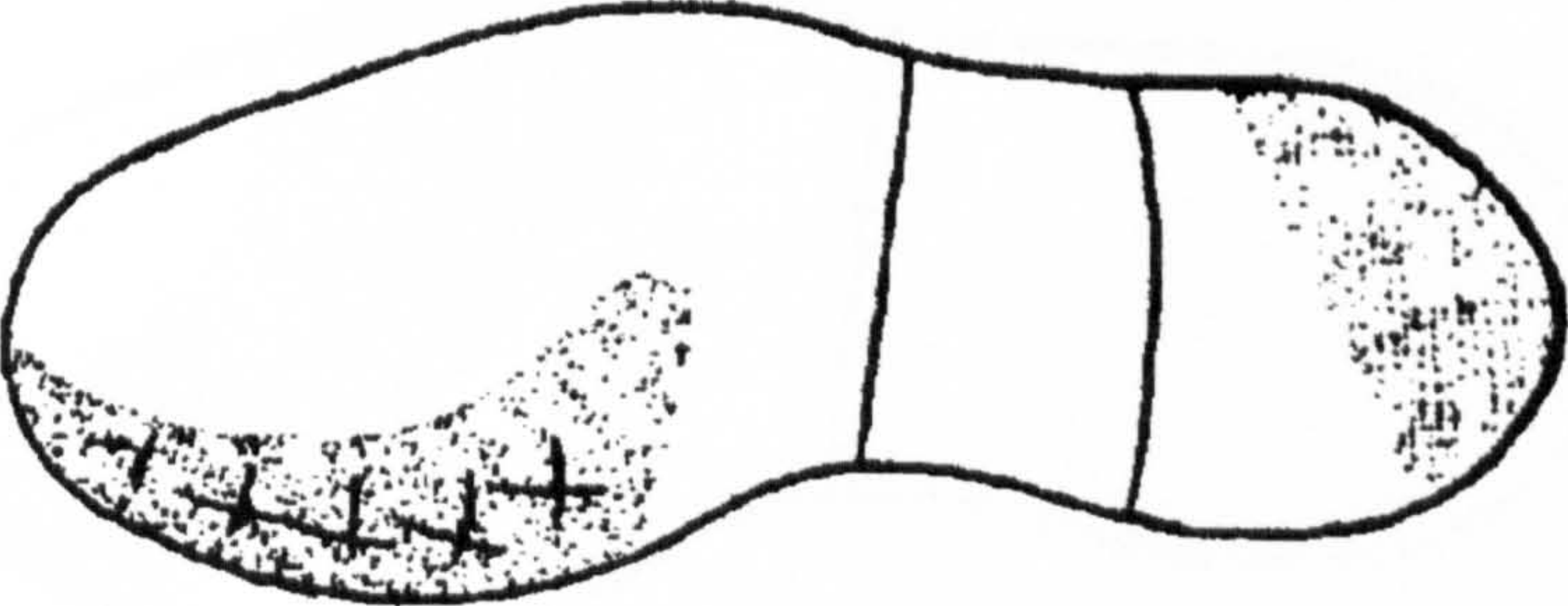
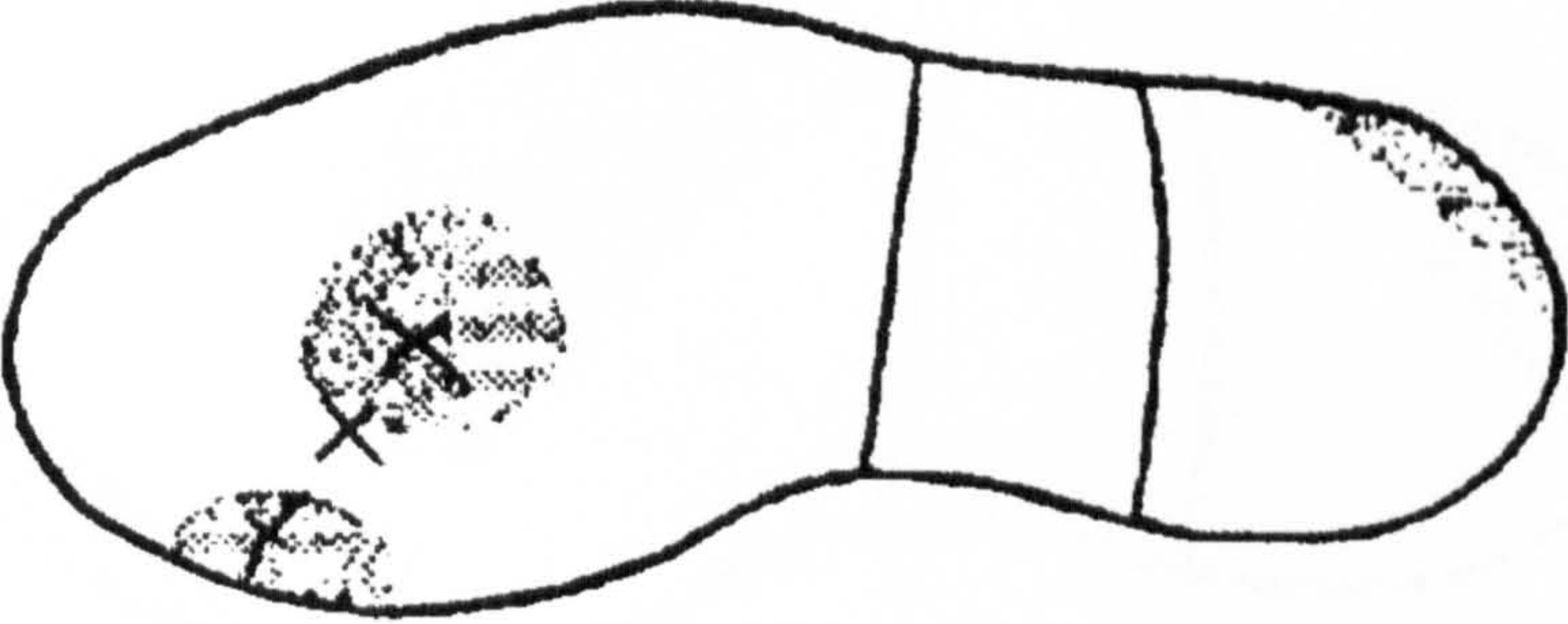
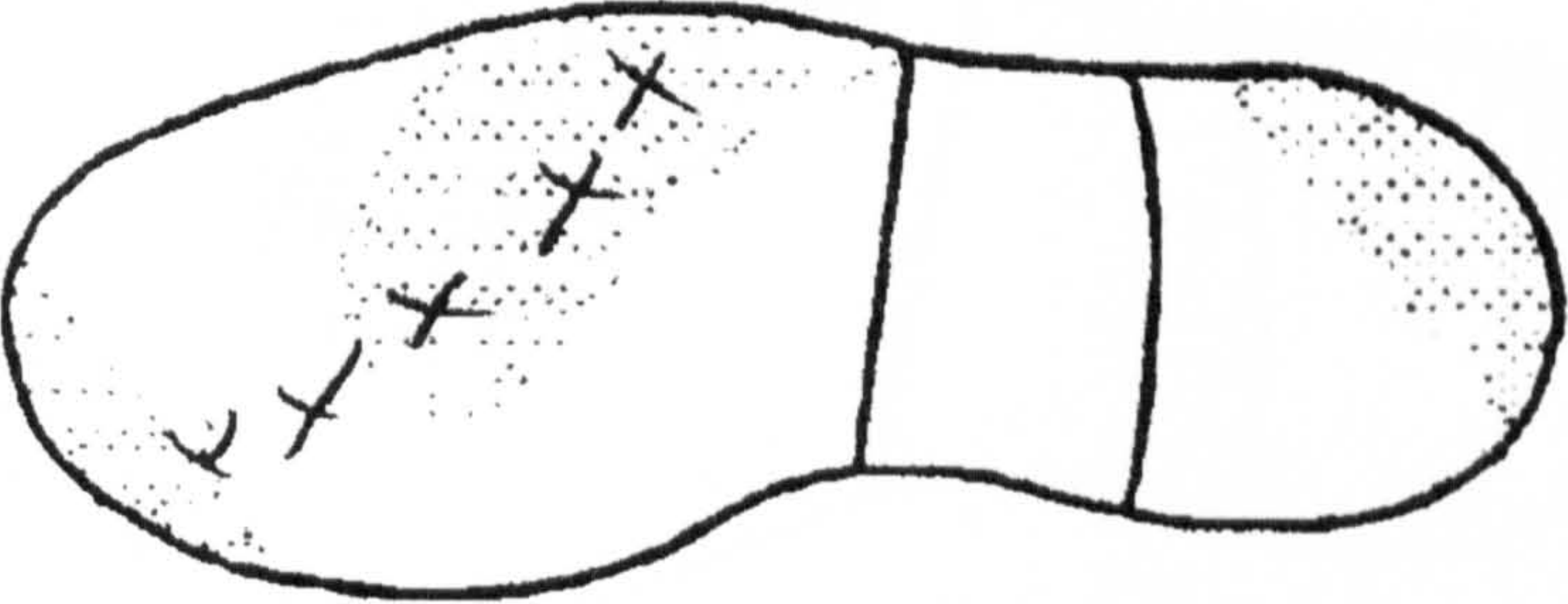
APPENDIX 8 Delphi round 3 – analysis of respondent comments given to justify viewpoints

Comment	Categories	Themes identified from grouping of categories	Inference
"no weight bearing"	Force pathway components	Factors affecting shoe wear patterns	Wear patterns can be influenced by variations in the force pathway
"taking weight instead"			
"toe off"			
"at heel strike"			
"heel strike " (X4)			
"compensation"	Compensation	Factors affecting shoe wear patterns	
"Uncompensated"			
"Valgus"	Foot pathology	Factors affecting shoe wear patterns	Wear patterns can be influenced by foot pathology
"Pes cavus"			
"valgus/pronation"			
"severely"	Severity (of condition)	Factors affecting shoe wear patterns	Wear patterns can be influenced by severity of a condition
"Mild case"			
"Normal"			
"amount of"			
"Pes Cavus"	Alternative pathology	Same wear pattern can be associated with different pathologies	Same wear pattern can be associated with different pathologies
"Cerebral Palsy"			
"distal wear"	Local site of wear	Contribution of local factors to shoe wear pattern formation	Local factors and local components of wear can have a direct effect on the overall wear pattern
"Anterior wear only"			
"at lat side"			
"Heel area only"			
"Wear on the medial border"			

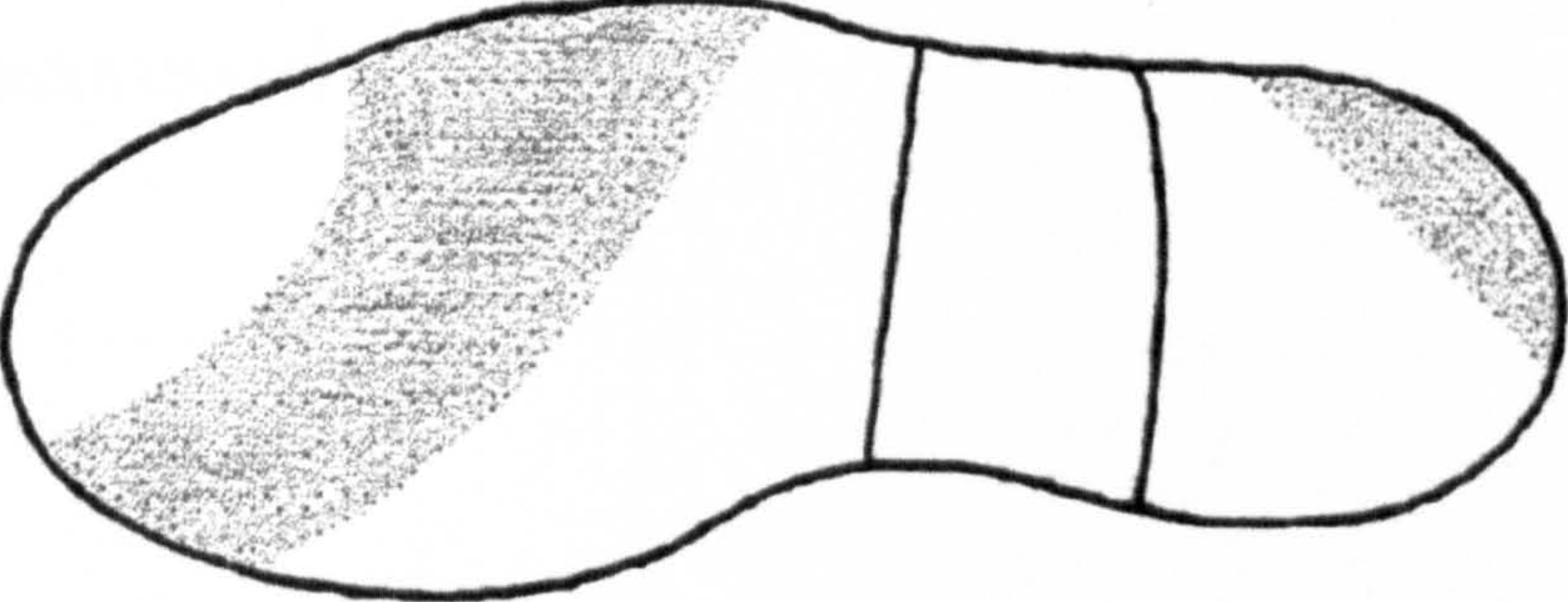
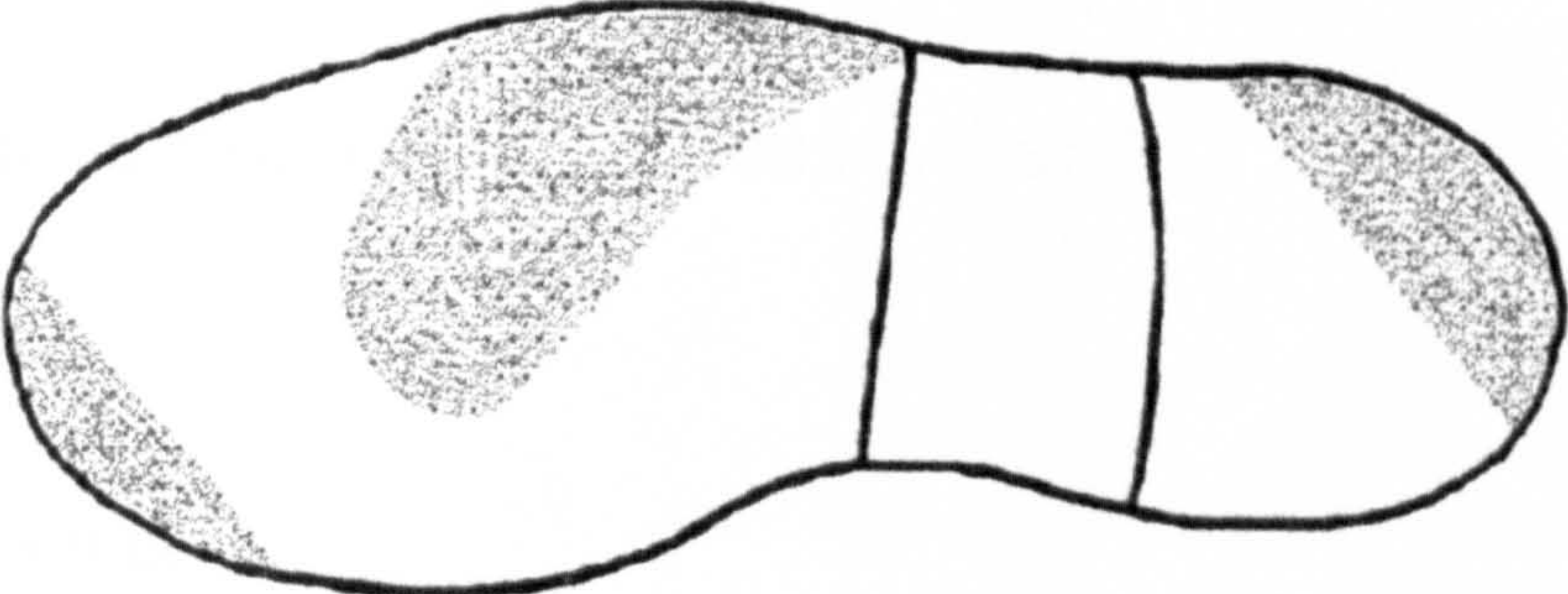

APPENDIX 8 – contd.

"medial" (X2)	Local site of wear	Contribution of local factors to shoe wear pattern formation	Local factors and local components of wear can have a direct effect on the overall wear pattern
"component of"			
"on medial border"			
"Wear towards the medial border of the heel"	Variations in amount of wear	Amount of component wear varies with different pathologies	
"Too dense"			
"Excessive wear"			
"Greater wear"	Description of local anatomical position	Contribution of local factors to shoe wear pattern formation	
"on 1 st M. Hd. – 2 nd met head"			
"1 st ray"			
"Incompetent 1 st ray"			
"hallux"			
"Calcaneo valgus"			
"Valgus heel"			
"Could also be"	Strength of relationship between pathology and wear	Level of certainty of relationship between pathology and wear	Certainty of relationship between pathology and wear can vary
"indicative of"			
"normally would only give"			
"Depends"			
"This might be a"			
"indicates"			
"causing oblique creasing shoe upper"	Effect on other parts of shoe	Other effects of factors involved in shoe wear production	Factors influencing wear patterns can affect other aspects of footwear

APPENDIX 9 Delphi round 3; marking centres from which wear was spreading - examples of markings which did not comply with the focal point principle

Pattern 1	Pattern 3	Pattern 8
		

APPENDIX 10 Comparison of agreed pattern associations for hallux rigidus in Delphi round 3, section 1, with previously published hallux rigidus pattern

Pattern 8	Pattern 9	Lucock (1980)
		

APPENDIX 11 Delphi round 4 questionnaire package

The SWaMP project round four questionnaire package contains the following:

1. Covering letter
2. Explanatory notes
3. Questionnaire round four, sections 1, 2 and 3
4. Feedback sheet
5. Stamped, addressed envelope

APPENDIX 11 - contd.

Covering letter

Podiatry and Chiropody Service

**Community Health Sheffield
Fulwood House
Old Fulwood Road
Sheffield
S10 3TH
0114 - 2716767**

Dear Sir/Madam

Thank you for your participation to date in the SWaMP project. The information that you have provided in the three previous questionnaire rounds has now been studied in detail and a number of preliminary conclusions have been made on the basis of the findings. These conclusions are now presented in the enclosed package. They summarise agreements reached between participants' in the last round and also include summary statements that I have made from the data examined. In order to conclude this stage of the project, I now need to present these findings to participants for final comment.

I would therefore be grateful if you could read through the three sections enclosed and either confirm your acceptance of the conclusions made on the basis of this study or state any areas of disagreement based on your own experiences.

Please note that although the package appears bulky, this is because of the volume taken up by graphic aspects of the package. It is envisaged that completion of this reply should only take a few more minutes of your time.

I would be grateful if you could complete and return this round in the envelope provided within three weeks of receipt of the package.

Thank you for your continuing help in this project.

Yours faithfully

D. W. Vernon
SWaMP Project Research Student
Sheffield Hallam University.

APPENDIX 11 - contd.

Explanatory notes

SWaMP project round four - explanatory notes

The results of the SWaMP round three questionnaire have now been collated and analysed and based on the results of this and information obtained in previous rounds, a number of conclusions have been made. These are in the form of agreements reached and comments stated on observations made over the three rounds. Round four is now presented for your comments and consists of three sections.

In **Section 1**, the patterns which you commented on in round three, section 1 are shown along with statements indicating whether participant agreement over associations between patterns and named conditions has been reached. As in previous rounds, the percentage of responses given for each possible associated condition is shown.

In **Section 2**, the pattern components for named conditions which you commented on in round three, section 1 are shown along with statements indicating whether participant agreement over associations between components and named conditions has been reached. As in section 1, the percentage of responses given for each possible associated component is shown.

In **Section 3**, a number of statements are presented, based on observations made on the information that has been provided by participants in the previous three rounds.

In round four, you are asked to consider the information presented in each section and to show whether you are in agreement with the conclusions presented. If you disagree with any of the conclusions made, please show which of the patterns, pattern component associations or statements you would disagree with and give a brief explanation of your alternative perspective.

I would be grateful if you could respond within three weeks of receipt of this round four. As in previous rounds, if you have any other comments regarding this round, please list these on the enclosed feedback sheet. If you would like a copy of the final report on the questionnaires, please tick the box on the feedback sheet.

If you have any problems with the questionnaire, please contact me on :

Daytime - 0114 - 2716767
Evenings - 01663 - 734414





Thank you once again for your assistance.

D.W. Vernon
SWaMP Project Research Student
Sheffield Hallam University

APPENDIX 11 – contd.





Delphi round 4, section 1a

This section shows agreements/rejections reached by participants in Round 3, Section 1. Please consider these and if you would agree with them overall, tick ✓ the box indicating agreement at the end of this section. If you disagree with any of the pattern associations/rejections, tick the box indicating disagreement, cross out any items you are in disagreement with and write in your alternative perspective.

<p><u>Pattern 1</u></p> 	<p><u>Accepted as being associated with :</u></p> <p>Pronated Foot (Complete acceptance by 100% of participants)</p> <p><u>Rejected as being associated with :</u></p> <p>Metatarsus Adductus (0% of participants in support)</p> <p>Calcaneo-Varus (0% of participants in support. Disputed by 20% of participants)</p>
<p><u>Pattern 2</u></p> 	<p><u>Accepted as being associated with :</u></p> <p>Retracted toes (Complete acceptance by 100% of participants)</p> <p><u>Rejected as being associated with :</u></p> <p>Pronated Foot (0% of participants in support)</p> <p>Forefoot Valgus (0% of participants in support)</p>
<p><u>Pattern 3</u></p> 	<p><u>Accepted as being associated with :</u></p> <p>Pronated Foot (Moderate acceptance by 40% of participants)</p> <p>Comp. Calc. Varus (Moderate acceptance by 40% of participants)</p> <p>Hallux Rigidus (Low acceptance by 20% of participants)</p> <p>Hallux Valgus (Low acceptance by 20% of participants)</p> <p><u>Rejected as being associated with :</u></p> <p>Ankle Equinus (0% of participants in support)</p>
<p><u>Pattern 4</u></p> 	<p><u>Accepted as being associated with :</u></p> <p>Hemiplegia (Complete acceptance by 100% of participants)</p> <p><u>Rejected as being associated with :</u></p> <p>Forefoot Varus (0% of participants in support)</p> <p>Freibergs Infraction (0% of participants in support)</p>



APPENDIX 11 – contd.

Delphi round 4, section 1b

<div>Pattern 5</div> 	<div>Accepted as being associated with</div> <div>Hammer 2nd toe (High acceptance by 80% of participants)</div> <div>Claw toes (Low acceptance by 20% of participants)</div> <div>No agreement reached for association with</div> <div>Pes Cavus (NO CONSENSUS with 20% of participants accepting the association and 20% disputing it)</div>
<div>Pattern 6</div> 	<div>Accepted as being associated with</div> <div>Talipes Eq. Varus (High acceptance by 80% of participants)</div> <div>Calc. Varus (Moderate acceptance by 40% of participants)</div> <div>Pes Cavus (Low acceptance by 20% of participants)</div> <div>Rejected as being associated with</div> <div>Hemiplegia (Disputed by 100% of participants)</div>
<div>Pattern 7</div> 	<div>Accepted as being associated with</div> <div>Ankle Equinus (Complete acceptance by 100% of participants)</div> <div>Rejected as being associated with</div> <div>Severs disease (0% of participants in support)</div>
<div>Pattern 8</div> 	<div>Accepted as being associated with</div> <div>Hallux Rigidus (Complete acceptance by 100% of participants)</div> <div>No agreement reached for association with</div> <div>Pes Cavus (NO CONSENSUS with 20% of participants accepting the association and 20% disputing it)</div>

APPENDIX 11 – contd.

Delphi round 4, section 1c

<p><u>Pattern 9</u></p> 	<p><u>Accepted as being associated with :</u></p> <p>Hallux Rigidus (High acceptance by 80% of participants) Short 1st Metatarsal (Low acceptance by 20% of participants)</p>
<p><u>Pattern 10</u></p> 	<p><u>Accepted as being associated with :</u></p> <p>Calcaneo Valgus (High acceptance by 60% of participants) Calcaneo Varus (High acceptance by 60% of participants)</p> <p><u>Rejected as being associated with :</u></p> <p>Hallux Rigidus (0% of participants in support) Forefoot Varus (0% of participants in support. Disputed by 20% of participants)</p> <p><u>No agreement reached for association with :</u></p> <p>Normal Foot (NO CONSENSUS with 20% of participants accepting the association and 20% disputing it)</p>

A.) I agree with the associations/rejections shown above as determined in the 3 previous questionnaire rounds ☐

B.) I disagree with the associations/rejections shown above as determined in the 3 previous questionnaire rounds ☐

(Please tick one of the above boxes as appropriate)

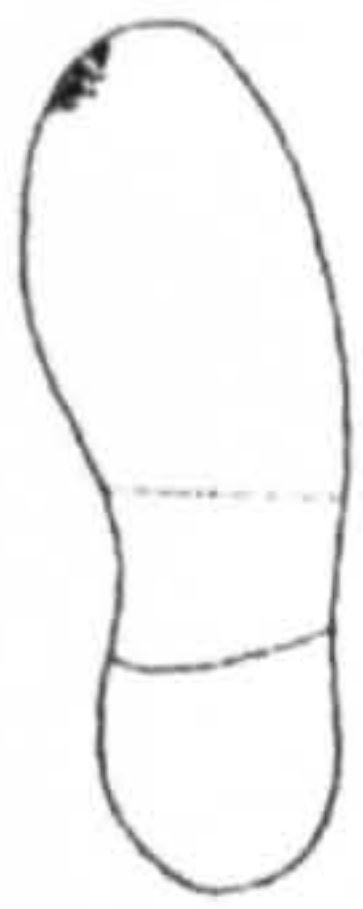







(N.B. If you have ticked box B. to show disagreement, please make any amendments clearly in the relevant section/sections)

APPENDIX 11 – contd.

Delphi round 4, section 2a

This section shows agreements reached by participants in Round 3 Section 2. Please consider these and if you would agree with them overall, please tick ✓ the box indicating agreement at the end of this section. If you disagree with any of the pattern associations or rejections, please tick the box indicating disagreement, cross out any items you are in disagreement with and write in your alternative perspective.



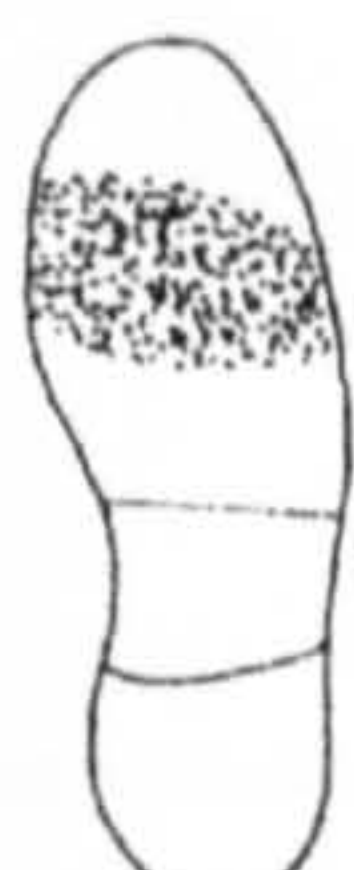

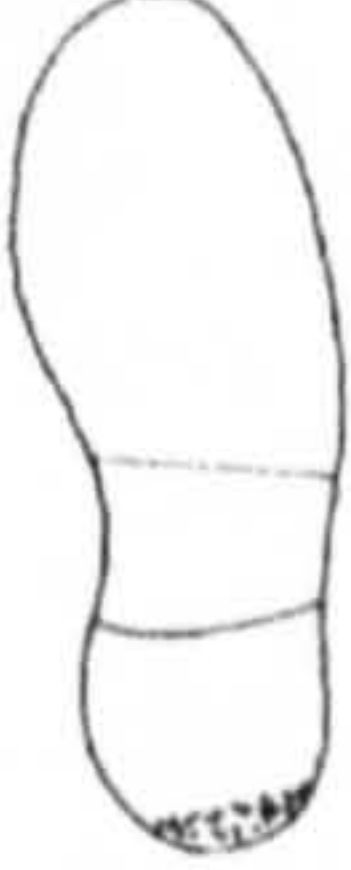


A. Pattern components associated with Calcaneo Valgus/Pronation

1		Rejected as being associated (0% of participants in support. Disputed by 60% of participants)	9		No agreement reached for association. (NO CONSENSUS with 20% of participants accepting the association and 20% disputing it)
2		Rejected as being associated (0% of participants in support. Disputed by 100% of participants)	10		Rejected as being associated (0% of participants in support. Disputed by 100% of participants)
3		No agreement reached for association. (NO CONSENSUS with 20% of participants accepting the association and 40% disputing it)	11		No agreement reached for association. (NO CONSENSUS with 60% of participants accepting the association and 20% disputing it)
4		Accepted as being associated (High acceptance by 80% of participants)	12		No agreement reached for association. (NO CONSENSUS with 40% of participants accepting the association and 20% disputing it)

APPENDIX 11 – contd.







Delphi round 4, section 2b



A. Pattern components associated with Calcaneo Valgus/Pronation (contd.)

5		<u>Accepted as being associated</u> (Complete acceptance by 100% of participants)
6		<u>No agreement reached for association</u> (NO CONSENSUS with 20% of participants accepting the association and 40% disputing it)
7		<u>Rejected as being associated</u> (0% of participants in support. Disputed by 100% of participants)
8		<u>No agreement reached for association</u> (NO CONSENSUS with 20% of participants accepting the association and 40% disputing it)
13		<u>No agreement reached for association</u> (NO CONSENSUS with 20% of participants accepting the association and 40% disputing it)
14		<u>No agreement reached for association</u> (NO CONSENSUS with 40% of participants accepting the association and 20% disputing it)
15		<u>No agreement reached for association</u> (NO CONSENSUS with 60% of participants accepting the association and 20% disputing it)

APPENDIX 11 – contd.

Delphi round 4, section 2c



B. Pattern components associated with Hallux Rigidus					
16		<u>Accepted as being associated</u> (High acceptance by 80% of participants)	19		<u>Rejected as being associated</u> (0% of participants in support. Disputed by 100% of participants)
17		<u>Rejected as being associated</u> (0% of participants in support. Disputed by 60% of participants)	20		<u>Accepted as being associated</u> (High acceptance by 80% of participants)
18		<u>Accepted as being associated</u> (High acceptance by 60% of participants)	21		<u>Accepted as being associated</u> (Complete acceptance by 100% of participants)

C. Pattern components associated with Calcaneo Varus					
22		<u>No agreement reached for association</u> (NO CONSENSUS with 60% of participants accepting the association and 20% disputing it)	24		<u>Accepted as being associated</u> (Complete acceptance by 100% of participants)

APPENDIX 11 – contd.

Delphi round 4, section 2d

C. Pattern components associated with Calcaneo Varus (contd.)

23	 Accepted as being associated (Complete acceptance by 100% of participants)	25	 No agreement reached for association (NO CONSENSUS with 40% of participants accepting the association and 40% disputing it)
----	--	----	---

- A.) I agree with the associations/rejections shown above as determined in the 3 previous questionnaire rounds ☐
- B.) I disagree with the associations/rejections shown above as determined in the 3 previous questionnaire rounds ☐

(Please tick one of the above boxes as appropriate)

(N.B. If you have ticked box B. to show disagreement, please make any amendments clearly in the relevant section/sections)

APPENDIX 11 – contd.

SWaMP questionnaire round 4, section 3

SWaMP questionnaire round 4, section 3

This section shows statements made at the end of the three rounds of questionnaire which you have participated in. The stages that the questionnaire has passed through have been :

Round 1 - Participants freely showed depictions of wear patterns that they would associate with named pathologies. When these were examined, wide ranges of patterns were observed in association with single named pathologies and some patterns were repeated across different pathologies. This was unexpected in light of previous publications which alluded to single characteristic pattern associations only.

Round 2 - Round one patterns which had been repeated across pathologies were presented back to participants. In a separate section, for pathologies where a wide range of patterns had been given, these patterns were separated into components and presented back to participants. In both sections, statistical information showing the proportion of participants who had supported each association was given and participants asked to show which associations they would support in light of the information presented. Replies showed a move towards agreement, however when patterns and pattern components were considered on the basis of the points from which the wear was spreading as opposed to the usual consideration of the full wear area, closer, more specific agreements were observed.

Round 3 - Round two patterns and pattern components were presented again to participants together with statistical information showing the proportion of participants who had supported each association in round two. A major shift towards agreement was noted, with participants tending to form agreement over so-called previously suggested classic wear pattern associations.

The following statements are made on the basis of findings from the previous three rounds. Please consider these and if you would agree with them overall, please tick ✓ the box indicating agreement at the end of this section. If you disagree with any of the statements, please tick the box indicating disagreement, cross out any items you are in disagreement with and write in your alternative perspective.

May I suggest that you read each statement out loud and spend a minute or two considering each one in detail.

APPENDIX 11 – contd.

SWaMP questionnaire round 4, section 3 (contd.)

SWaMP questionnaire round 4, section 3 (contd.)

- 1. *"The previously assumed belief that one specific condition will cause one characteristic wear pattern only is incorrect, with single conditions being capable of producing a range of wear patterns."*
.....
- 2. *"Although a range of wear patterns can occur with single named conditions, previously assumed characteristic patterns may be the most commonly observed patterns associated with that condition."*
.....
- 3. *"The agreements reached in Round 3 of the questionnaires relate to the most commonly occurring wear patterns associated with each condition concerned."*
.....
- 4. *"When several different wear patterns can occur with single named conditions, this implies that several different modes of function are occurring with these conditions."*
.....
- 5. *"If a range of patterns and not one characteristic pattern only are possible with single named conditions, the absence of a characteristic pattern would not necessarily imply the absence of the associated condition."*
.....
- 6. *"When more than one pathology is present, some pathologies can have greater influence over the type of wear pattern which will be created than others."*
.....
- 7. *"Wear is a primary product of foot function and not simply of it's fixed anatomy/morphology, although these factors can have a secondary influence on wear."*
.....
- 8. *"Wear can be amended/influenced by external factors (e.g. shoe style, shoe fit, sports and occupational activity, habit)."*
.....

APPENDIX 11 – contd.

SWaMP questionnaire round 4, section 3 (contd.)

SWaMP questionnaire round 4, section 3 (contd.)

9. *"Wear patterns can be usefully interpreted and compared by considering the points from which the wear is spreading (focal points). These points relate to specific anatomical positions of the foot."*

10. *"Participants were more confident of their opinions in round 3 of the questionnaires than they were in round 1"*

11. *"Participants found the task of sketching wear patterns from memory as in round 1 more difficult than that of commenting on a given wear pattern as in the subsequent rounds."*

12. *"In round 1, some participants may have showed wear patterns taken from direct patient observation for the purpose of the questionnaire."*

13. *"The reduced number of responses from participants in round 3 may have been because the request to justify minority opinions over associated wear patterns was too difficult."*

14. *"Where agreements have not been reached in round 3, this may be because the patterns depicted are uncommon and outside the experience of some participants."*

15. *"Where agreements have not been reached in round 3, misdiagnosis of the associated condition by some participants may have been a contributory factor."*

16. *"Where agreements have not been reached in round 3, this may be because there is no one commonly expected pattern, but instead a wide range of uncommon patterns in association with the named conditions."*

17. *"The questionnaires stimulated an awareness of wear patterns and caused participants to look at wear pattern associations more closely, which in turn led to greater understanding of wear patterns."*

APPENDIX 11 – contd.

SWaMP questionnaire round 4, section 3 (contd.)

A.) I agree with the statements made above as determined from the three previous questionnaire rounds ☐

B.) I disagree with the statements made above as determined from the three previous questionnaire rounds ☐

(Please tick one of the above boxes as appropriate)

(N.B. If you have ticked box B. to show disagreement, please state clearly, the reason for disagreement, by the relevant statement/statements)

APPENDIX 11 - contd.

SWaMP project round four feedback sheet

Name of participant :

I have the following comments to make on round four :

(Please continue on separate sheet if necessary)

If you would like a copy of the final report on the questionnaires, please tick the box below

Please send me a copy of the final questionnaire report when completed

☐

Thank you for your assistance.

**D. W. Vernon
Research student
SWaMP project
Sheffield Hallam University**

APPENDIX 12 Pre-questionnaire survey package

The SWaMP questionnaire package contains the following :

1. Covering letter
2. Explanatory notes
3. List of structural/functional states of the foot and gait
4. Questionnaire
5. Stamped, addressed envelope

DWV 20/1/96

APPENDIX 12 – contd.

Covering letter

Podiatry and Chiropody Service

**Community Health Sheffield
Fulwood House
Old Fulwood Road
Sheffield
S10 3TH
0114 - 2716767**

Dear Sir/Madam

I am a state-registered chiropodist conducting research into shoe wear marks as part of the requirement for a M.Phil./Ph.D. study at Sheffield Hallam University. This project is being undertaken in the belief that if the marks were placed on a grid, they would be useful in chiropody/podiatry teaching, clinical diagnosis and in crime scene examination where worn shoe prints are found. The project is known as the SWaMP (shoe wear mark) project.

As there is currently no basic information available on shoe wear marks, I initially require experienced chiropodists to name conditions for which they have knowledge of wear marks in order to provide a focus for the study.

I am therefore writing to all heads of Trust podiatry/chiropody services to request participation in the project. I would be grateful if you could choose an appropriate experienced chiropodist from your staff to participate in the questionnaire, giving them the enclosed explanatory notes and questionnaire to complete which can then be returned to me in the stamped, addressed envelope for collation.

Thank you for your anticipated help in this project.

Yours faithfully

D. W. Vernon
SWaMP Project Research Student
Sheffield Hallam University

APPENDIX 12 – contd.

Explanatory Notes

SWaMP Project Questionnaire - Explanatory Notes

Thank you for assisting in this project. I am a state-registered chiropodist undertaking research into shoe wear marks as part of the requirement for a M.Phil./Ph.D. study at Sheffield Hallam University. This project is being undertaken in the belief that if shoe wear marks were placed on a grid, they would be useful in chiropody/podiatry teaching, clinical diagnosis and crime scene evaluation where worn shoe prints are found. The project is known as the SWaMP (shoe wear mark) project. As there is currently no basic information available on shoe wear marks, I initially require experienced chiropodists to name conditions for which they have a knowledge of wear marks in order to provide a focus for the study.

In this initial questionnaire, you are asked to name any of the conditions from the enclosed list for which you can identify the associated shoe sole wear marks. Please name 3 or more conditions but only up to a maximum of 10. *It is important that you only name conditions for which you already have wear mark knowledge/experience.*

Your response will be received in confidence and your anonymity will be respected at all times.

Please could the questionnaire be completed and returned to me within 3 weeks of receipt in the pre-paid envelope. If you have any problems, please contact me on :

0114 - 2716767 (Daytime)

Thank you once again for your assistance.

D. W. Vernon
SWaMP Project Research Student
Sheffield Hallam University.

APPENDIX 12 – contd.

List of structural/functional states sent to participants

ABDUCTION	ABDUCTION AND EVERSION
ADDUCTION	ADDUCTION AND EVERSION
ANKLE EQUINUS	ATAXIC GAIT
BOW LEGS	CALCANEAL APOPHYSITIS
CALCANEAL BURSITIS	CALCANEAL EVERSION
CALCANEAL GAIT	CALCANEAL SPUR
CALCANEAL-CAVUS	CALCANEAL VALGUS
CALCANEAL-VARUS	CALCANEAL-VARUS (COMPENSATED)
CHARCOT JOINTS	CHOREA
CLAW TOES	DIGITI QUINTI VARUS
DROP FOOT	EQUINO-CAVUS
EQUINO-VARUS	EXCESSIVE ANKLE DORSIFLEXION
FOOT STRAIN	FOREFOOT VALGUS
FOREFOOT VARUS	FREIBERG'S INFRACTION
GENU VALGUM	GENU VARUM
HALLUX FLEXUS	HALLUX RIGIDUS
HALLUX VALGUS	HAMMERED 2ND TOE
HEMIPLEGIC GAIT	HIGH STEPPING GAIT
HINDFOOT VALGUS	HINDFOOT VARUS
HYPERMOBILE 1ST AND 5TH MPJTS	HYPERMOBILE FOOT
INFLARED FOOT	INTOED GAIT
KOHLERS DISEASE	LOWER MOTOR NEURONE WEAKNESS
METATARSUS ADDUCTUS	METATARSUS PRIMUS ELEVATUS
METATARSUS PRIMUS VARUS	OUT-TOED GAIT
OVERLOADED 2ND MET.	PAINFUL NAIL DISORDERS OF THE 1ST TOE
PARAPARESIS	PARAPLEGIC GAIT
PES CAVUS	PES PLANO-VALGUS
PLANTAR DIGITAL NEURITIS (MORTON'S TOE)	PLANTAR FASCIITIS
PLANTAR FLEXED 1ST AND 5TH TOES	PLANTAR FLEXED TOES
POST-OPERATIVE STATES	PRONATED FOOT
PYRAMIDAL NEUROLOGICAL DISORDERS	REDUCTION OF LONGITUDINAL AND TRANSVERSE ARCHES
RETRACTED TOES	RETRO-CALCANEAL BURSITIS
RHEUMATOID ARTHRITIS	SEVERS DISEASE
SHORT 1ST METATARSAL	SHORT 5TH METATARSAL
SHUFFLING GAIT IN PARKINSONISM	SPLAYING OF THE METATARSALS
TAYLORS BUNION	TALIPES CALCANEAL VALGUS
TALIPES CALCANEAL VARUS	TALIPES EQUINO VALGUS
TALIPES EQUINO VARUS	TARSAL ARTHRITIS
VERTICAL TALUS	WADDLING GAIT

APPENDIX 12 – contd.

Pre-questionnaire survey

SWaMP Project Questionnaire	
Name
Employing Trust
Work Address
Tel. No.
Please list a minimum of 3 and a maximum of 10 conditions for which you could identify characteristic shoe sole wear marks based on experience and knowledge of these marks.	
	Condition
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Please return the form to : <div>Wesley Vernon Podiatry and Chiropody Service Community Health Sheffield Fulwood House Old Fulwood Road Sheffield S10 3TH</div>	

APPENDIX 13 Main questionnaire package

The 2nd SWaMP questionnaire package contains the following :

1. Covering letter
2. Explanatory notes
3. Example sheet
4. Questionnaire
4. Stamped, addressed envelope

DWV 4/6/96

APPENDIX 13 – contd

Covering letter

**Podiatry and Chiropody Service
Community Health Sheffield
Fulwood House
Old Fulwood Road
Sheffield
S10 3TH
Tel.: 0114 - 2716767**

Dear Sir/Madam

Thank you for participation in the initial SWaMP project questionnaire that I distributed earlier this year. The results of the questionnaire have now been collated. They show that Podiatrists have knowledge/experience of certain shoe wear mark patterns that relate to conditions affecting the foot and/or gait.

The next phase of the research is to explore Podiatrist's experience of some of these shoe wear marks further. I would be grateful if you could forward the enclosed questionnaire package to the appropriately experienced Podiatrist whom you chose for participation in the initial questionnaire for completion and return.

Thank you again for your help with this project.

Yours faithfully

**Wesley Vernon
SWaMP Project Research Student
Sheffield Hallam University.**

APPENDIX 13 - contd.

Explanatory Notes

SWaMP Project 2nd Questionnaire : Explanatory Notes

Thank you for participation in the initial SWaMP project questionnaire that I distributed earlier this year. The collated responses showed that Podiatrists have experience of certain shoe wear mark patterns that relate to conditions affecting the foot and/or gait. Of the replies received, the four most common conditions participants said that they had shoe wear mark knowledge of were:

1. Pronated Foot
2. Hallux Rigidus
3. Rearfoot Varus
4. Pes Cavus

I would now like to invite you to participate in an exercise to explore Podiatrist's experience of these shoe wear marks further. A questionnaire form is enclosed on which blank shoe outsoles are presented with the above named conditions. Participants are required to sketch the wear pattern or patterns that they would associate with these named conditions on the blank outsoles. An example is included for your reference showing the preferred style of representation. If more than one wear pattern is known for each condition, please sketch the pattern that you believe is the most commonly occurring first and place any subsequent patterns in decreasing order of frequency of occurrence. **It is essential that patterns are drawn from experience and not from direct patient observation or theoretical knowledge.**

If you wish to show even more wear patterns for the named conditions than there is space for, please photocopy the sheet as required. All replies will be received and dealt with anonymously.

I would therefore be grateful if you would complete the enclosed questionnaire and return this to me within three weeks of receipt. A stamped addressed envelope is enclosed for your assistance.

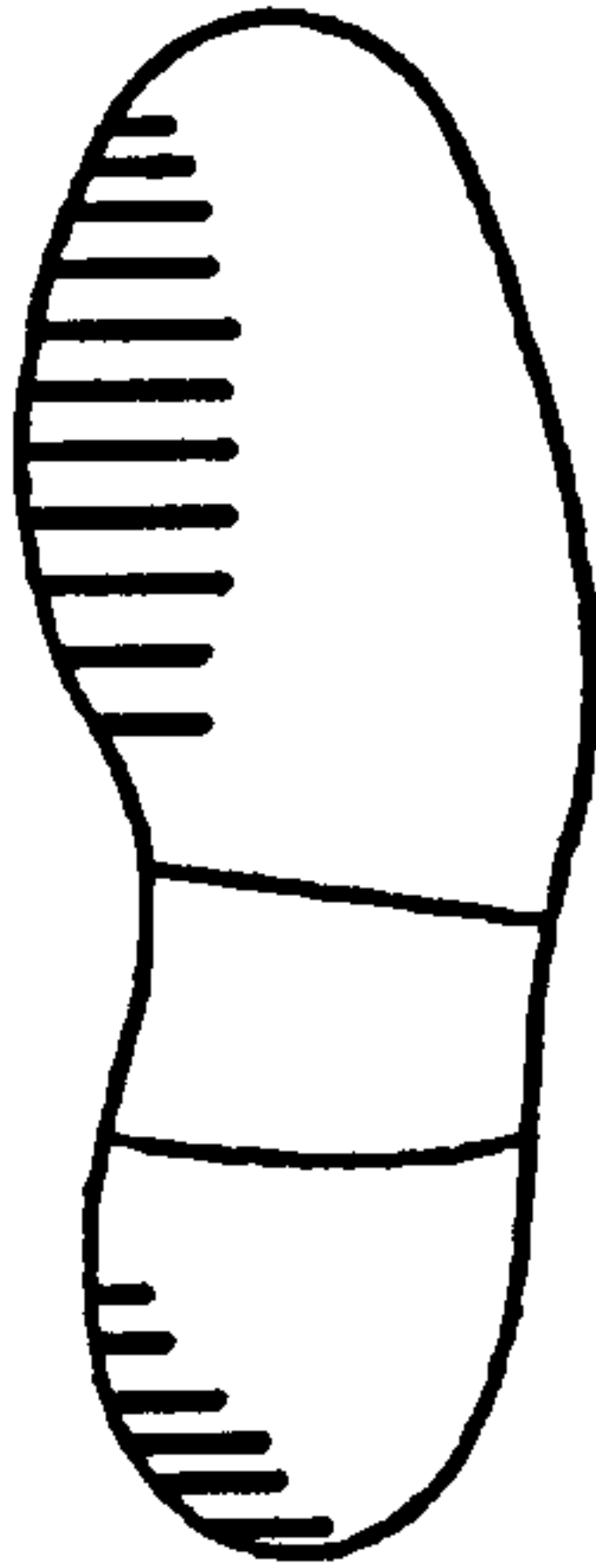
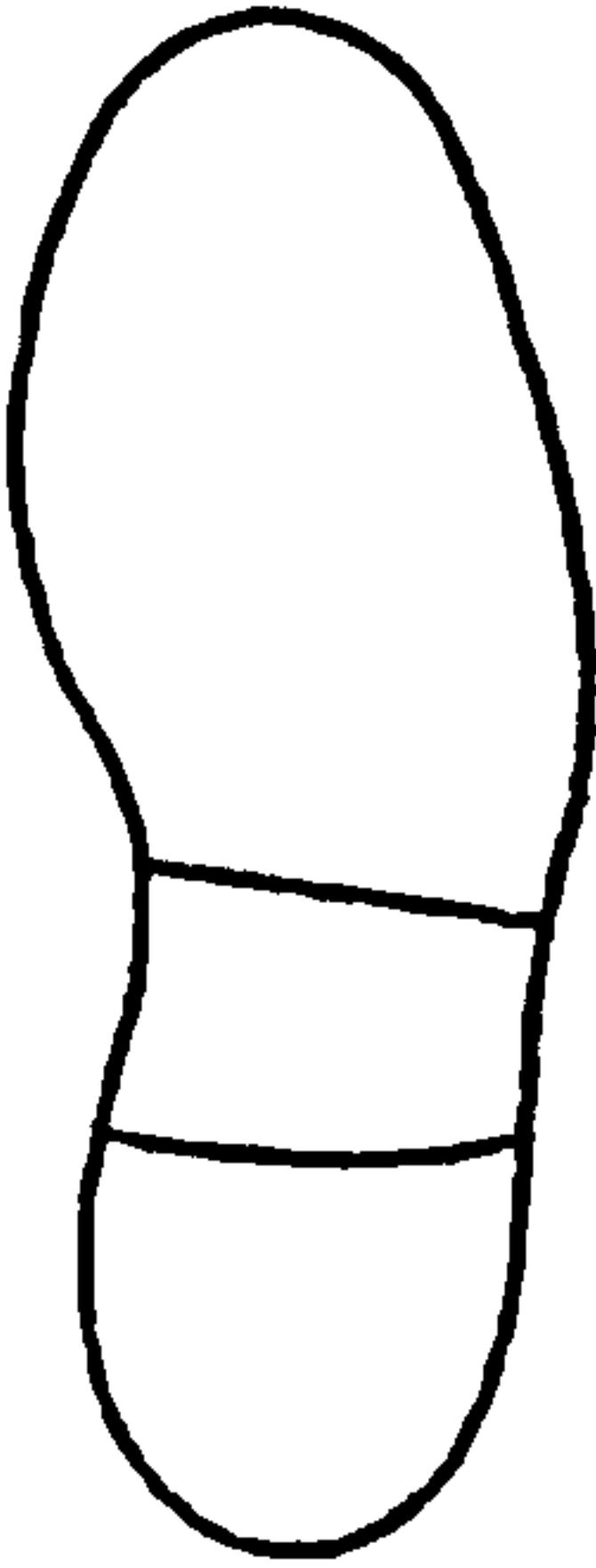
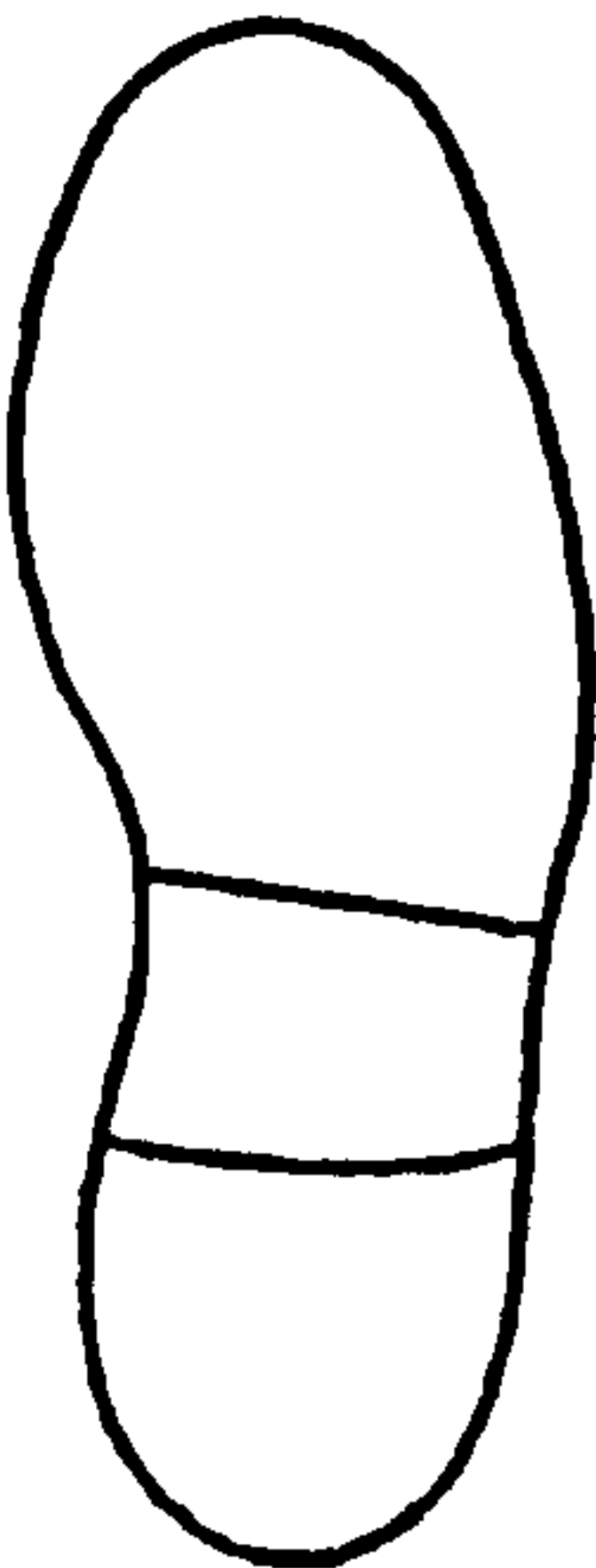
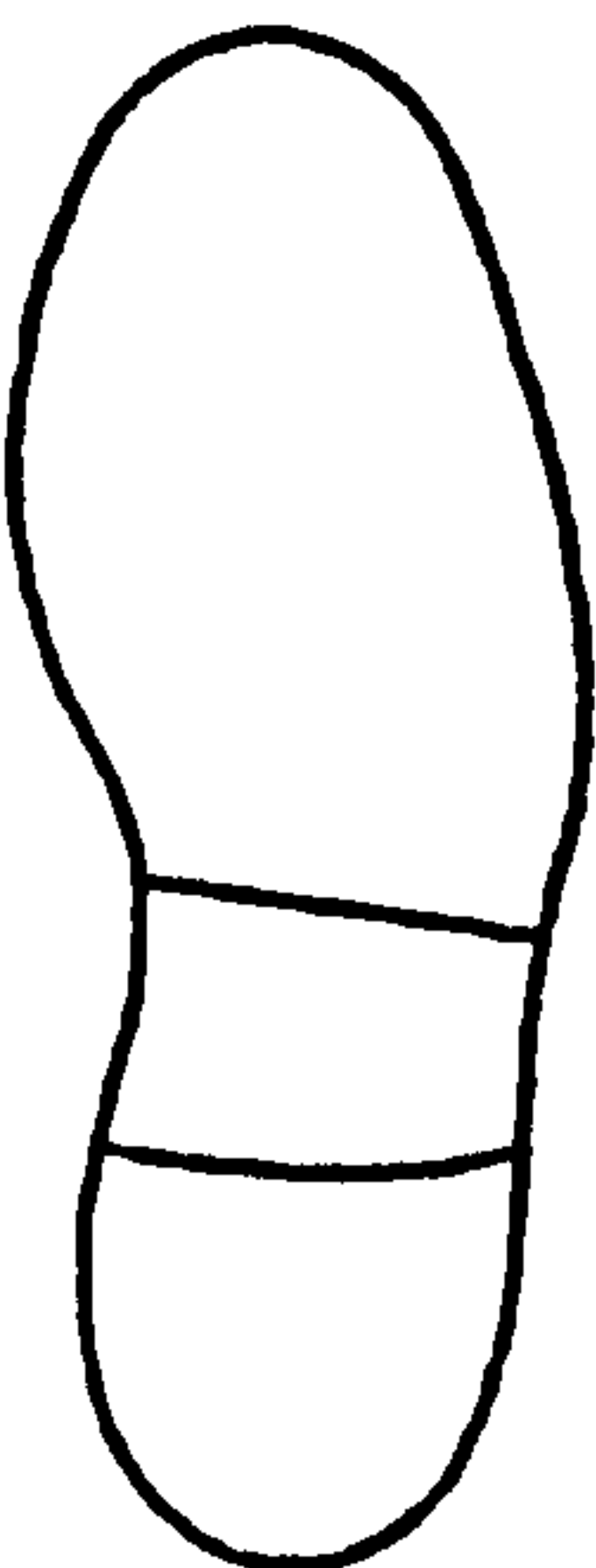
Thank you again for your help with this project.

Yours faithfully

























Wesley Vernon
SWaMP Project Research Student
Sheffield Hallam University.

APPENDIX 13 – contd.

Example sheet









SWaMP 2nd Questionnaire			
Example			
Pronated foot			
			
Reason for variation -----	Reason for variation -----	Reason for variation -----	Reason for variation -----

2nd SWaMP Questionnaire











<div>2nd SWaMP Questionnaire</div> <p>Please sketch the wear marks that you would associate with the named conditions on the blank outsole outlines using the preferred style shown on the example sheet. If you associate more than one pattern with a condition, state the reason for the difference (e.g. compensation) and place the patterns in order of frequency of occurrence with the most commonly occurring pattern first.</p> <div>Pronated Foot</div> <table><tr><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td></td><td></td><td></td><td></td></tr><tr><td></td><td>Reason for variation -----</td><td>Reason for variation -----</td><td>Reason for variation -----</td></tr></table> <div>Hallux Rigidus</div> <table><tr><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td></td><td></td><td></td><td></td></tr><tr><td></td><td>Reason for variation -----</td><td>Reason for variation -----</td><td>Reason for variation -----</td></tr></table>				1	2	3	4						Reason for variation -----	Reason for variation -----	Reason for variation -----	1	2	3	4						Reason for variation -----	Reason for variation -----	Reason for variation -----
1	2	3	4																								
																											
	Reason for variation -----	Reason for variation -----	Reason for variation -----																								
1	2	3	4																								
																											
	Reason for variation -----	Reason for variation -----	Reason for variation -----																								

APPENDIX 13 – contd.

2nd SWaMP Questionnaire (contd.)

2nd SWaMP Questionnaire (contd.)			
Rearfoot Varus			
1	2	3	4
			
	Reason for variation	Reason for variation	Reason for variation
	-----	-----	-----
Pes Cavus			
1	2	3	4
			
	Reason for variation	Reason for variation	Reason for variation
	-----	-----	-----

APPENDIX 14 Example of inductive analysis of wear patterns by pathology and pattern form

Patterns given				
<div>I/D HR 11/2</div> <div>Sub Theme</div> <div>Supination</div> <div>FPCode</div> <div>1/6/13/18/19</div> 	<div>I/D HR 16/1</div> <div>Sub Theme</div> <div>None</div> <div>FPCode</div> <div>1/14/15/20</div> 	<div>I/D HR 20/1</div> <div>Sub Theme</div> <div>None</div> <div>FPCode</div> <div>1/14/15/20</div> 	<div>I/D HR 2/1</div> <div>Sub Theme</div> <div>None</div> <div>FPCode</div> <div>1/17/20</div> 	<div>I/D HR 3/1</div> <div>Sub Theme</div> <div>None</div> <div>FPCode</div> <div>1/17/20</div> 
<div>I/D Pron 11/2</div> <div>Sub Theme</div> <div>Rearfoot Valgus</div> <div>FPCode</div> <div>4/16/17</div> 	<div>I/D Pron 20/3</div> <div>Sub Theme</div> <div>Forefoot Varus</div> <div>FPCode</div> <div>4/16/17</div> 	<div>I/D Pron 34/4</div> <div>Sub Theme</div> <div>Fully comp.</div> <div>FPCode</div> <div>1/16/17</div> 	<div>I/D Pron 5/2</div> <div>Sub Theme</div> <div>Rearfoot Valgus</div> <div>FPCode</div> <div>4/16/17</div> 	<div>I/D Pron 7/1</div> <div>Sub Theme</div> <div>None</div> <div>FPCode</div> <div>1/16/17</div> 
Division of patterns by category				
Pattern reference	1. Pathology categories	2. Focal code predominance categories	3. Detailed focal code categories	4. Variable given
Pron 34/4	Pronation	16/17	1/16/17	Fully compensated
Pron 7/1			1/16/17	-----
Pron 5/2			4/16/17	Rearfoot Valgus
Pron 11/2			4/16/17	Rearfoot Valgus
Pron 20/3			4/16/17	Forefoot Varus
HR 2/1	Hallux Rigidus	17/20	1/17/20	-----
HR 3/1			1/17/20	-----
HR 11/2		13/18/19	1/6/13/18/19	Supination
HR 16/1		14/15/20	1/14/15/20	-----
HR 20/1			1/14/15/20	-----

APPENDIX 15 Sample of pattern sub-categories based on focal code descriptions

From the category of patterns exhibiting ‘localised central metatarso-phalangeal joint wear’ (33 Patterns), the following sub-categories were derived:





1. Localised central metatarso-phalangeal joint wear with posterior/posterior-lateral heel wear’	
Pathology	Pattern Reference
Pronation	42/2, 8/2, 16/3, 32/1, 22/2, 5/3, 32/4
Hallux rigidus	32/2, 50/2
Pes cavus	22/2, 6/2, 24/1, 1/1, 8/2, 42/3
Rearfoot varus	23/1, 18/3, 22/2, 9/1, 16/1, 23/3, 29/1
2. Localised central metatarso-phalangeal joint wear with no heel wear’	
Pathology	Pattern Reference
Pronation	32/1, 22/2, 5/3, 32/4
Hallux rigidus	32/2
Pes cavus	22/2
Rearfoot varus	22/2
3. Localised central metatarso-phalangeal joint wear with 1 st / tip of 1 st wear’	
Pathology	Pattern Reference
Pronation	35/2, 37/2, 43/1, 11/3
Hallux rigidus	23/1, 40/1, 29/1, 23/2, 50/2
Pes cavus	8/3
Rearfoot varus	29/1
4. Localised central metatarso-phalangeal joint wear with medial heel wear	
Pathology	Pattern Reference
Pronation	25/3, 13/2, 3/1,26/1
Hallux rigidus	26/1

APPENDIX 15 – contd.

From the above categories, the following focal code sub-categories were derived:

Focal code sub-categories for ‘central metatarsal wear with posterior/posterior-lateral heel wear’	
Focal Code	Pattern Reference
1/15	PRON - 42/2, 8/2, 16/3
	RFV – 16/1, 9/1, 18/3, 23/1
	PC – 1/1, 6/2, 8/2
2/15	PC – 24/1, 42/3
1/14	RFV – 23/3
Focal code sub-categories for ‘central metatarsal wear with no heel wear’	
Focal Code	Pattern Reference
15	PRON – 32/1, 22/2, 5/3, 32/4
	RFV – 22/2
	PC – 22/2
	HR – 32/2
Focal code sub-categories for ‘central metatarsal wear with 1 st / tip of 1 st wear	
Focal Code	Pattern Reference
1/15/20	PRON – 35/2, 37/2, 43/1, 11/3
	HR – 40/1, 29/1
6/15/20	PC - 8/3
15/20	HR – 23/1, 23/2
15/17	HR – 50/2
1/3/15/18/20	RFV – 29/1
Focal code sub-categories for ‘central metatarsal wear with medial heel wear’	
Focal Code	Pattern Reference
1/3/15/20	HR – 26/1
1/4/15/20	PRON – 26/1
4/15/20	PRON – 3/1
2/3/4/9/14	PRON – 25/3
4/9/15	PRON – 13/2

APPENDIX 16 Illustration of hermeneutic circle traced in wear pattern analysis

<div> <div>Wear pattern</div> <div>I/D HR 11/2</div> <div>Sub Theme</div> <div>Supination</div> <div>FPCode</div> <div>1/6/13/18/19</div> </div> 	⇒	<div>Focal code</div> <div>1/6/13/18/19</div>	⇓
⇑	<div>“Leap of hermeneutic understanding”</div> <div>Hallux rigidus suggests that the usual foot/ground contact cannot be expected due to the stiff 1st toe . Supination suggests a turning inwards of the foot. The focal code describes wear of the lateral outsole border suggesting that the normal force pathway has not been followed with a more lateral pathway avoiding the 1st toe stiffness. Foot anatomy suggests the lateral aspects of the foot contacting the ground</div> 		<div>Normal force pathway</div> 
<div>Supination</div> <div>Inversion (turning in along an axis running from front to back) of the foot</div>			⇓
⇑	<div>Hallux Rigidus</div> <div>1st toe is fixed and does not dorsiflex (bend upwards) at the 1st metatarso-phalangeal joint</div>	⇐	<div>Foot anatomy normally in ground contact while walking</div> 

APPENDIX 17 Patterns suggesting more than one function

Pronation patterns		
Pattern reference	Focal code	Suggested functions
PRON 1/1	1/9/15/16/17/20	1. Foot contacts normally with mid stance pronation and no attempt to recover 2. Abducted foot
PRON 7/1	1/16/17	1. Foot contacts normally with mid stance pronation and no attempt to recover 2. Abducted foot
PRON 7/2	1/9/16/17	1. Foot contacts normally with mid stance pronation and no attempt to recover 2. Abducted foot
PRON 8/1	1/17/20	1. Foot contacts normally with later pronation and attempt to stabilise via functional hallux limitus 2. Abducted foot
PRON 11/1	1/16/17	1. Foot contacts normally with mid stance pronation and no attempt to recover 2. Abducted foot
PRON 11/3	1/15/20	1. Foot contacts normally with later pronation and attempt to stabilise via functional hallux limitus 2. Abductory twist 3. Abducted foot
PRON 14/1	1/16/17/20	1. Foot contacts normally with mid stance pronation and no attempt to recover 2. Abducted foot
PRON 15/1	1/9/20	1. Foot contacts normally with later pronation and attempt to stabilise via functional hallux limitus 2. Abducted foot
PRON 16/1	1/15/16/17	1. Foot contacts normally with mid stance pronation and no attempt to recover 2. Abductory twist
PRON 17/1	1/15/16/17	1. Foot contacts normally with mid stance pronation and no attempt to recover 2. Abductory twist
PRON 20/2	1/14/15/20	1. Foot contacts normally with later pronation and attempt to stabilise via functional hallux limitus 2. Abductory twist
PRON 21/1	1/13/14/15/16/17	1. Foot contacts normally with late pronation 2. Abductory twist
PRON 21/4	1/13/15/16/17	1. Foot contacts normally with late pronation 2. Abductory twist
PRON 22/1	6/17/20	1. Foot lands in inversion to compensate for pronation, then later pronates fully 2. Abducted foot
PRON 23/1	1/16/17	1. Foot contacts normally with mid stance pronation and no attempt to recover 2. Abducted foot
PRON 24/2	2/14/15/20	1. Foot contacts normally with later pronation and attempt to stabilise via functional hallux limitus 2. Abductory twist
PRON 26/3	1/2/3/13/15/20	1. Foot pronates rapidly on contact and attempts to recover through supination 2. Abductory twist

APPENDIX 17 - contd.

Pattern reference	Focal code	Suggested functions
PRON 29/1	1/15/16/17	1. Foot contacts normally with mid stance pronation and no attempt to recover 2. Abductory twist
PRON 30/1	1/16/17	1. Foot contacts normally with mid stance pronation and no attempt to recover 2. Abducted foot
PRON 31/2	1/14/15/20	1. Foot contacts normally with later pronation and attempt to stabilise via functional hallux limitus 2. Abductory twist
PRON 33/2	1/15/16/17/20/21	1. Abductory twist 2. Abducted foot
PRON 34/4	1/16/17	1. Foot contacts normally with mid stance pronation and no attempt to recover 2. Abducted foot
PRON 35/1	1/20	1. Foot contacts normally with later pronation and attempt to stabilise via functional hallux limitus 2. Abducted foot
PRON 35/2	1/15/20	1. Foot contacts normally with later pronation and attempt to stabilise via functional hallux limitus 2. Abductory twist 3. Abducted foot
PRON 35/3	1/20	1. Foot contacts normally with later pronation and attempt to stabilise via functional hallux limitus 2. Abducted foot
PRON 36/1	1/16/17/20	1. Foot contacts normally with mid stance pronation and no attempt to recover 2. Abducted foot
PRON 37/1	1/20	1. Foot contacts normally with later pronation and attempt to stabilise via functional hallux limitus 2. Abducted foot
PRON 37/2	1/15/20	1. Foot contacts normally with later pronation and attempt to stabilise via functional hallux limitus 2. Abductory twist 3. Abducted foot
PRON 40/1	1/10/16/17/20	1. Foot lands in inversion to compensate for pronation, then later pronates fully 2. Abducted foot
PRON 43/1	1/15/20	1. Foot contacts normally with later pronation and attempt to stabilise via functional hallux limitus 2. Abductory twist 3. Abducted foot
PRON 43/2	1/2/6/15/16/17	1. Foot lands in inversion to compensate for pronation, then later pronates fully 2. Abductory twist
PRON 44/1	1/16/17	1. Foot contacts normally with mid stance pronation and no attempt to recover 2. Abducted foot
PRON 50/1	1/6/7/9/10/16/17/20	1. Foot lands in inversion to compensate for pronation, then later pronates fully 2. Abducted foot

APPENDIX 17 - contd.

Pattern reference	Focal code	Suggested functions
PRON 50/3	1/6/10/15/16/17	1. Foot lands in inversion to compensate for pronation, then later pronates fully 2. Abductory twist 3. Abducted foot
PRON 51/1	6/16	1. Foot lands in inversion to compensate for pronation, then later pronates fully 2. Abducted foot
PRON 51/3	6/15/16/17	1. Foot lands in inver/sion to compensate for pronation, then later pronates fully 2. Abductory twist
PRON 52/2	1/16/17/20	1. Foot contacts normally with mid stance pronation and no attempt to recover 2. Abducted foot
PRON 54/2	1/14/15/16/20	1. Foot contacts normally with later pronation and attempt to stabilise via functional hallux limitus 2. Abducted foot
PRON 55/2	1/16/17/21	1. Foot contacts normally with mid stance pronation and no attempt to recover 2. Foot contacts normally with later pronation and attempt to stabilise via functional hallux limitus
Hallux rigidus patterns		
Pattern reference	Focal code	Suggested functions
HR 12/2	17/20	1. Abducted gait 2. Pronation with abducted gait
HR 14/2	16/20/21	1. No medial or lateral deviation from normal gait pathway 2. Adductory twist
HR 21/1	1/12/13/14/15/20	1. Classic hallux rigidus function 2. Forefoot inversion
HR 23/2	15/20	1. Classic hallux rigidus function 2. Abductory twist
HR 25/2	13/20	1. Classic hallux rigidus function 2. Forefoot inversion
HR 26/1	1/3/15/20	1. Classic hallux rigidus function 2. Abductory twist
HR 28/1	1/13/20	1. Classic hallux rigidus function 2. Forefoot inversion
HR 29/1	1/15/20	1. Classic hallux rigidus function 2. Abductory twist
HR 31/3	13/16/18	1. Forefoot inversion 2. Adductory twist
HR 32/4	1	1. Calcaneal gait 2. Walking predominantly on heels
HR 33/1	1/6/13/17/18/20/21	1. Classic hallux rigidus function 2. Compensatory supination/inversion of the foot
HR 34/1	1/13/20	1. Classic hallux rigidus function 2. Forefoot inversion
HR 42/2	1/12/13/20	1. Classic hallux rigidus function 2. Forefoot inversion
HR 46/1	13/16/18	1. Adducted gait 2. Adductory twist

APPENDIX 17 - contd.

Pattern reference	Focal code	Suggested functions
HR 47/1	14/15	1. Abductory twist 2. Stamping gait 3. Vertical toe off
HR 48/3	1/9/16/17/20	1. Abducted gait 2. Pronation with abducted gait
HR 49/1	1/16/20/21	1. No medial or lateral deviation from normal gait pathway 2. Adductory twist
HR 51/1	15/16/17	1. Abducted gait 2. Abductory twist
HR 54/1	6/7/18/19/21	1. Compensatory supination/inversion of the foot 2. Compensatory supination/inversion of the foot 3. Forefoot inversion
HR 55/2	1/13/16/20	1. No medial or lateral deviation from normal gait pathway 2. Adductory twist
Pes Cavus patterns		
Pattern reference	Focal code	Suggested functions
PC 12/2	1/16	1. Normal or inverted heel, everted forefoot 2. Feet abducted
PC 28/1	1/13/16/17	1. Normal or inverted heel, everted forefoot 2. Feet abducted
PC 28/2	6/7/13/18/19/21	1. Foot inverted throughout 2. Foot inverted and abducted throughout
PC 31/1	6/7/12/13/18/19/21	1. Foot inverted throughout 2. Foot inverted and abducted throughout
PC 32/1	1/16/17	1. Normal or inverted heel, everted forefoot 2. Feet abducted
PC 34/2	6/13/16/18	1. Foot inverted throughout 2. Foot inverted and abducted throughout
PC 35/1	3/13/14/15/16/21	1. Everted heel 2. Feet abducted
PC 39/1	1/16	1. Normal or inverted heel, everted forefoot 2. Feet abducted
PC 47/3	16	1. No heel strike due to dropped forefoot of pes cavus and everted forefoot 2. Abductory twist
PC 47/4	15/16	1. No heel strike due to dropped forefoot of pes cavus and everted forefoot 2. Abductory twist
PC 48/4	1/13/15/16/17/20	1. Normal or inverted heel, everted forefoot 2. Feet abducted
Rearfoot varus patterns		
Pattern reference	Focal code	Suggested functions
RFV 1/3	1/13/18	1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction 3. Foot is inverted throughout with adduction
RFV 2/2	1/13/14/18	1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction

APPENDIX 17 - contd.

Pattern reference	Focal code	Suggested functions
RFV 5/4	6/13/20	1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction
RFV 6/2	13/15/20/21	1. Forefoot supination 2. Adductory twist
RFV 8/1	1/13	1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction 3. Foot is inverted throughout with adduction
RFV 11/1	1/13/14/15/17	1. Forefoot supination 2. Adductory twist
RFV 12/2	1/12/13/14/15	1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction
RFV 15/1	1/13/18/20	1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction
RFV 18/1	6/13/20	1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction
RFV 20/3	1/12/13/14/15/18/19	1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction
RFV 21/1	1/12/13/18/20	1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction
RFV 22/1	6/13	1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction 3. Foot is inverted throughout with adduction
RFV 23/2	1/13	1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction 3. Foot is inverted throughout with adduction
RFV 26/2	1/13	1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction 3. Foot is inverted throughout with adduction
RFV 28/2	1/6/7/13/14/15/18/19	1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction
RFV 29/2	6/7/18/19/21	1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with adduction
RFV 33/2	1/6/7/12/13/18/19	1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction 3. Foot is inverted throughout with adduction
RFV 34/2	1/13	1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction

APPENDIX 17 - contd.

Pattern reference	Focal code	Suggested functions
RFV 35/2	6/13/20	<ol style="list-style-type: none"> 1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction
RFV 37/2	1/13/18	<ol style="list-style-type: none"> 1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction 3. Foot is inverted throughout with adduction
RFV 39/1	1/19/20/21	<ol style="list-style-type: none"> 1. Foot is inverted on heel strike and remains inverted throughout 2. Forefoot supination 3. Adductory twist
RFV 42/1	1/12/13	<ol style="list-style-type: none"> 1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction 3. Foot is inverted throughout with adduction
RFV 48/1	1/13/14/15/18	<ol style="list-style-type: none"> 1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction
RFV 52/1	1/13/18	<ol style="list-style-type: none"> 1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction 3. Foot is inverted throughout with adduction
RFV 52/3	1/13/14/15/18	<ol style="list-style-type: none"> 1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction
RFV 52/4	6/13	<ol style="list-style-type: none"> 1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction 3. Foot is inverted throughout with adduction
RFV 53/2	1/13/14/15/20	<ol style="list-style-type: none"> 1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction
RFV 53/4	1/13/21	<ol style="list-style-type: none"> 1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction
RFV 54/2	1/13/18	<ol style="list-style-type: none"> 1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction 3. Foot is inverted throughout with adduction
RFV 55/3	6/7/12/13/17	<ol style="list-style-type: none"> 1. Foot is inverted on heel strike and remains inverted throughout 2. Foot is inverted throughout with abduction

APPENDIX 18 Patterns repeated across pathology categories

Focal code	No. Pathologies affected	Pattern references
1/15	Pronation - 3	PRON - 42/2, 8/2, 16/3
	Rearfoot varus - 4	RFV - 16/1, 9/1, 18/3, 23/1
	Pes cavus - 3	PC - 1/1, 6/2, 8/2
15	Pronation - 4	PRON - 32/1, 22/2, 5/3, 32/4
	Rearfoot varus - 1	RFV - 22/2
	Pes cavus - 1	PC - 22/2
	Hallux rigidus - 1	HR - 32/2
1/15/20	Pronation - 4	PRON - 35/2, 37/2, 43/1, 11/3
	Hallux rigidus - 2	HR - 40/1, 29/1
14/15	Rearfoot varus - 1	RFV - 32/2
	Hallux rigidus - 1	HR - 47/1
1/14/15	Rearfoot varus - 3	RFV - 53/1, 20/1, 54/3
	Pronation - 1	PRON - 20/1
1/2/3/4/9/14/15	Rearfoot varus - 1	RFV - 31/1
	Pronation - 1	PRON - 31/1
1/13/14/15/16	Pes cavus - 8	PC - 13/2, 17/1, 36/1, 11/1, 44/1, 48/3, 41/1, 37/1
	Rearfoot varus - 2	RFV - 44/1, 42/2
2/13/14/15/16/17/20	Pronation - 1	PRON - 28/3
	Rearfoot varus - 2	RFV - 28/1, 28/3
1/13/14/15/16/17	Pes cavus - 2	PC - 28/3, 48/2
	Pronation - 1	PRON - 21/1
6/13/14/15/16/17	Pes cavus - 1	PC - 48/1
	Hallux rigidus - 1	HR - 48/2
1/13/14/15	Rearfoot varus - 2	RFV - 13/1, 16/2
	Pes cavus - 1	PC - 24/3
	Hallux rigidus - 1	HR - 53/2
4/13/14/15/20/21	Pronation - 1	PRON - 31/3
	Rearfoot varus - 1	RFV - 31/3
1/13/18	Pronation - 1	PRON - 30/2
	Rearfoot varus - 4	RFV - 52/1, 37/2, 1/3, 54/2
	Pes cavus - 1	PC - 49/1
12/13	Pes cavus - 1	PC - 32/2
	Hallux rigidus - 1	HR - 32/3
1/14/15/20	Pronation - 2	PRON - 20/2, 31/2
	Rearfoot varus - 2	RFV - 20/2, 35/3
	Hallux rigidus - 6	HR 6/1, 20/1, 8/1, 16/2, 16/1, 4/1
1/13/14/15/17	Rearfoot varus - 1	RFV - 11/1
	Hallux rigidus - 1	HR - 42/1
1/13/15/20	Pes cavus - 1	PC - 8/1
	Hallux rigidus - 1	HR - 55/1
13/15/20	Hallux rigidus - 1	HR - 26/2
	Hallux rigidus - 1	HR - 29/2
1/13/20	Pronation - 1	PRON - 11/4
	Hallux rigidus - 3	HR - 34/1, 28/1, 45/1
1/13/16	Rearfoot varus - 2	RFV 53/3, 26/3
	Pronation - 2	PRON 34/3, 50/4
	Pes cavus - 6	PC 53/1, 43/1, 23/1, 13/1, 26/1, 45/1
1/16	Pronation - 1	PRON 12/1
	Rearfoot varus - 4	RFV 18/2, 4/1, 38/1, 12/1
	Pes cavus - 2	PC 12/2, 39/1













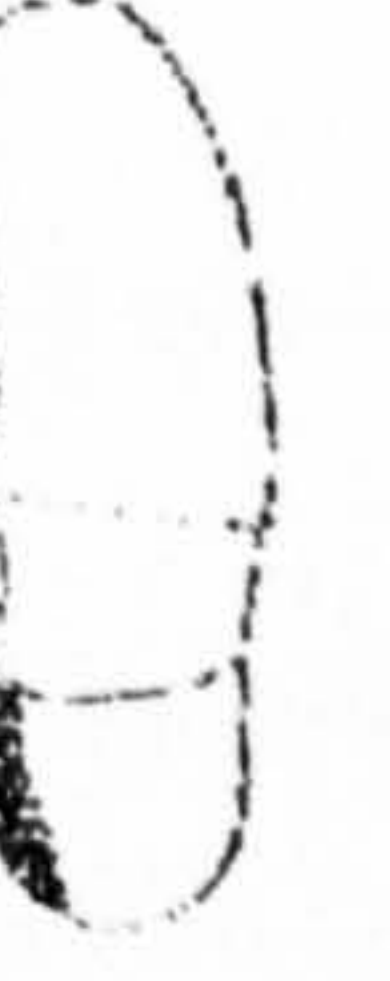
APPENDIX 18 – contd.

Focal code	No. Pathologies affected	Pattern references
6	Pronation - 2	PRON 45/1, 17/3
	Pes cavus - 1	PC 47/3
	Hallux rigidus - 2	HR 36/1, 46/2
1/16/17	Pronation - 6	PRON 44/1, 7/1, 23/1, 11/1, 30/1, 18/1
	Rearfoot varus - 4	RFV 30/1, 14/1, 11/2, 34/3
	Pes cavus - 1	PC 32/1
	Hallux rigidus - 1	HR 11/1
4/9/16/17	Pronation - 3	PRON 5/2, 6/2, 20/3
	Rearfoot varus - 1	RFV 7/2
2/3/4/9/16/17	Pronation - 1	PRON 19/1
	Hallux rigidus - 1	HR 19/1
4/16/17/20	Pronation - 4	PRON 53/3, 28/2, 49/1, 29/2
	Hallux rigidus - 1	HR 28/2
2/15/16/17	Pronation - 2	PRON 44/2, 53/4
	Rearfoot varus - 1	RFV 2/1
1/15/16/17/20/21	Pronation - 2	PRON 33/2, 4/1
	Hallux rigidus - 1	HR 31/1
17	Hallux rigidus - 1	HR – 7/1
	Pronation - 1	PRON – 32/2
1/20	Pronation - 3	PRON – 35/1, 35/3, 37/1
	Rearfoot varus - 1	RFV – 35/1
	Hallux rigidus - 5	HR – 17/1, 8/2, 11/3, 18/1, 53/1
20	Pronation - 1	PRON – 46/2
	Hallux rigidus - 4	HR – 10/1, 14/1, 25/1, 32/1
1/17/20	Pronation - 1	PRON – 8/1
	Rearfoot varus - 1	RFV – 36/1
	Hallux rigidus - 4	HR – 41/1, 3/1, 2/1, 50/1
6/17/20	Rearfoot varus - 1	RFV – 40/1
	Pronation - 1	PRON 22/1
6/7/18/19/21	Rearfoot varus - 1	RFV – 29/2
	Hallux rigidus - 1	HR – 54/1
9	Pronation - 1	PRON – 32/3
	Rearfoot varus - 1	RFV – 32/3
1	Pes cavus - 1	PC – 39/2
	Hallux rigidus - 1	HR – 32/4
1/2/6	Pronation - 1	PRON – 28/1
	Rearfoot varus - 1	RFV – 19/1
6/7	Rearfoot varus - 1	RFV – 25/1
	Pronation - 1	PRON – 25/2
















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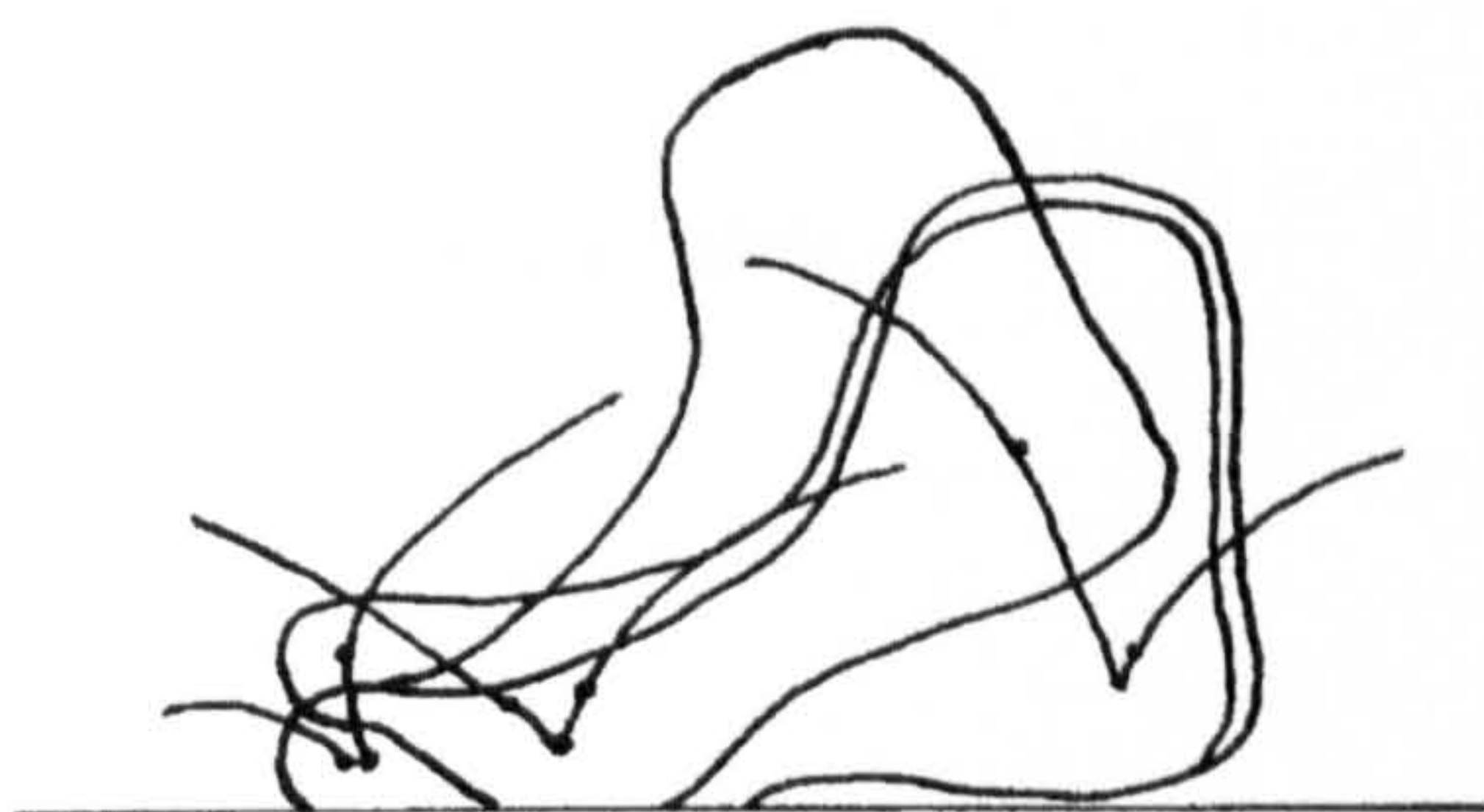









APPENDIX 19.1 Functions suggested by patterns with pronation

Function and description						Previously suggested by
Foot pronated prior to heel strike and throughout stance <i>Foot is fixed in pronation before heel strikes, therefore striking medially with the force pathway remaining medial as pronation remains</i>						Root, Orien and Weed (p303) Neale (p44)
Theoretical movements in the sagittal plane						Force pathway
Not applicable						
Respondent patterns in support						
PRON 34/1	PRON 23/2	PRON 50/2	PRON 48/2	PRON 47/1	PRON 51/4	
						
PRON 18/3	PRON 14/2	PRON 8/3	PRON 17/2	PRON 11/2	PRON 5/2	
						







APPENDIX 19.1 – contd.

Respondent patterns in support (contd.)					
PRON 6/2	PRON 20/3	PRON 16/2	PRON 25/1	PRON 13/1	PRON 49/1
					
PRON 53/3	PRON 28/2	PRON 29/2	PRON 36/2	PRON 15/2	PRON 38/2
					
PRON 55/1	PRON 51/2	PRON 2/2			
					







APPENDIX 19.2 Functions suggested by patterns with pronation

Function and description		Previously suggested by			
<u>Heel equinus causing centralised heel contact and later pronation to compensate</u> <i>A heel equinus results in a central heel strike and an central force pathway. As restricted dorsiflexion is encountered, the foot pronates to accommodate this, redirecting the force pathway medially</i>		Root, Orien and Weed (p174) Neale (p47)			
Theoretical movements in the sagittal plane		Force pathway			
					
Respondent patterns in support					
PRON 18/2	PRON 2/1	PRON 43/3	PRON 39/1	PRON 44/2	PRON 53/4
					
PRON 28/3	PRON 24/1				
					







APPENDIX 19.3 Functions suggested by patterns with pronation

Function and description					Previously suggested by
<p>Foot pronated prior to heel strike with attempt to recover via supination As the foot lands in pronation, an attempted recovery through supination directs the force pathway more laterally</p>					<p>Root, Orien and Weed (p120) Neale (p38)</p>
Theoretical movements in the sagittal plane					Force pathway
<p>Not applicable</p>					
Respondent patterns in support					
PRON 13/2	PRON 3/1	PRON 21/2	PRON 21/3	PRON 31/3	
					














APPENDIX 19.4 Functions suggested by patterns with pronation

Function and description					Previously suggested by
<p><u>Foot pronates rapidly on contact and remains pronated throughout stance</u> <i>Foot is not in fixed pronation, but pronates on heel strike, directing the force pathway medially. The force pathway remains medially as it progresses anteriorly</i></p>					Neale (p44)
Theoretical movements in the sagittal plane					Force pathway
<p>Not applicable</p>					
Respondent patterns in support					
PRON 19/1	PRON 52/1	PRON 54/4	PRON 48/1	PRON 54/3	
					

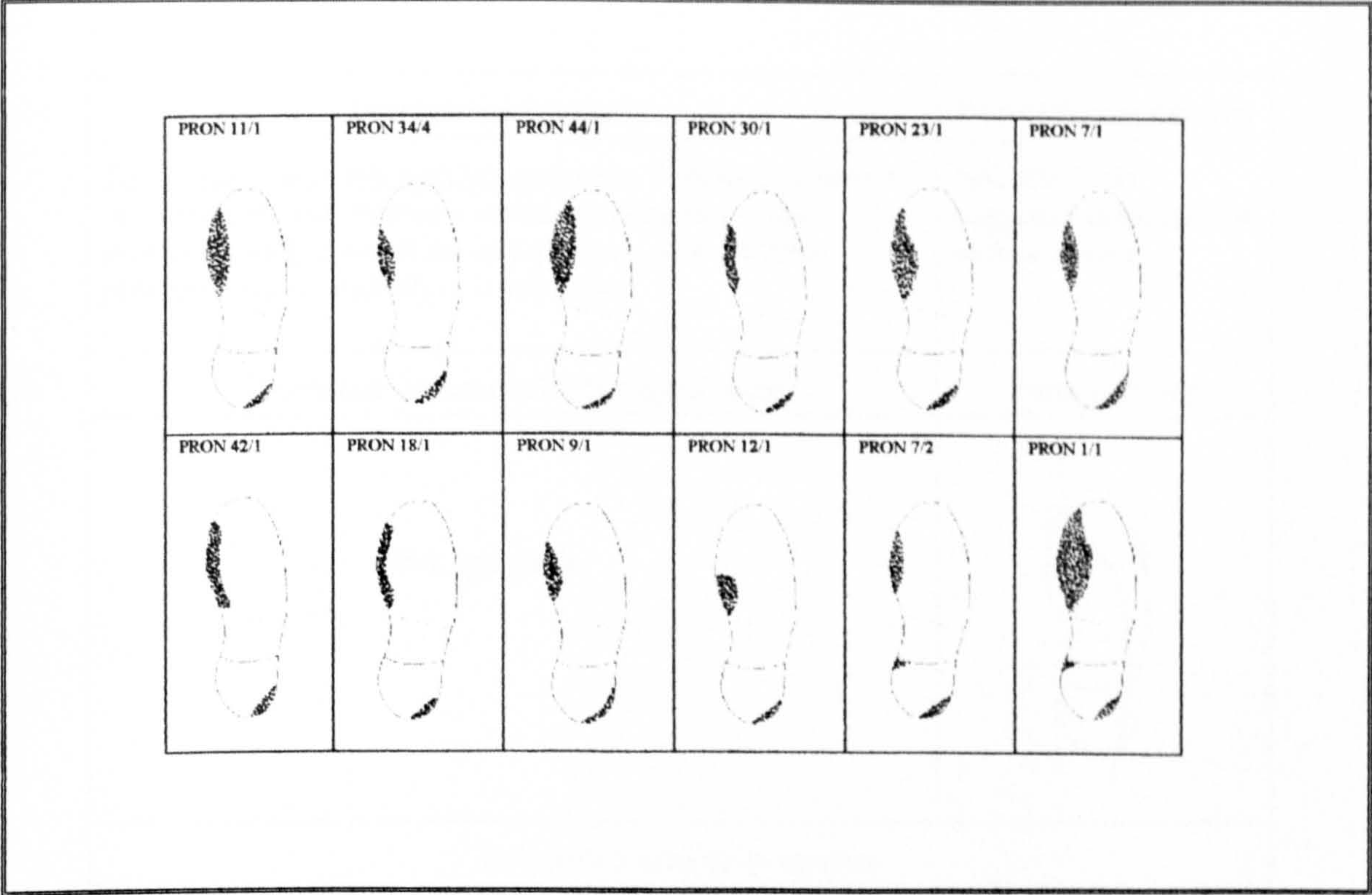
APPENDIX 19.5 Functions suggested by patterns with pronation

Function and description					Previously suggested by
<p>Foot pronates rapidly on contact and attempts to recover via forefoot supination Foot is not in fixed pronation, but pronates on heel strike, directing the force pathway medially. An attempted recovery through supination directs the force pathway more laterally</p>					Root, Orien and Weed (p174)
Theoretical movements in the sagittal plane					Force pathway
Not applicable					
Respondent patterns in support					
PRON 26/1	PRON 25/3	PRON 26/2	PRON 31/1	PRON 26/3	
					






APPENDIX 19.6 Functions suggested by patterns with pronation

Function and description		Previously suggested by			
<u>Foot contacts normally with mid-stance pronation and no attempt to recover</u> After normal heel strike, the pronates at the subtalar joint, redirecting the force pathway medially		Neale (p47)			
Theoretical movements in the sagittal plane		Force pathway			
Not applicable					
Respondent patterns in support					
PRON 41/1	PRON 54/1	PRON 29/1	PRON 38/1	PRON 55/3	PRON 16/1
					
PRON 17/1	PRON 47/4	PRON 14/1	PRON 36/1	PRON 52/2	PRON 55/2
					















APPENDIX 19.6 – contd.



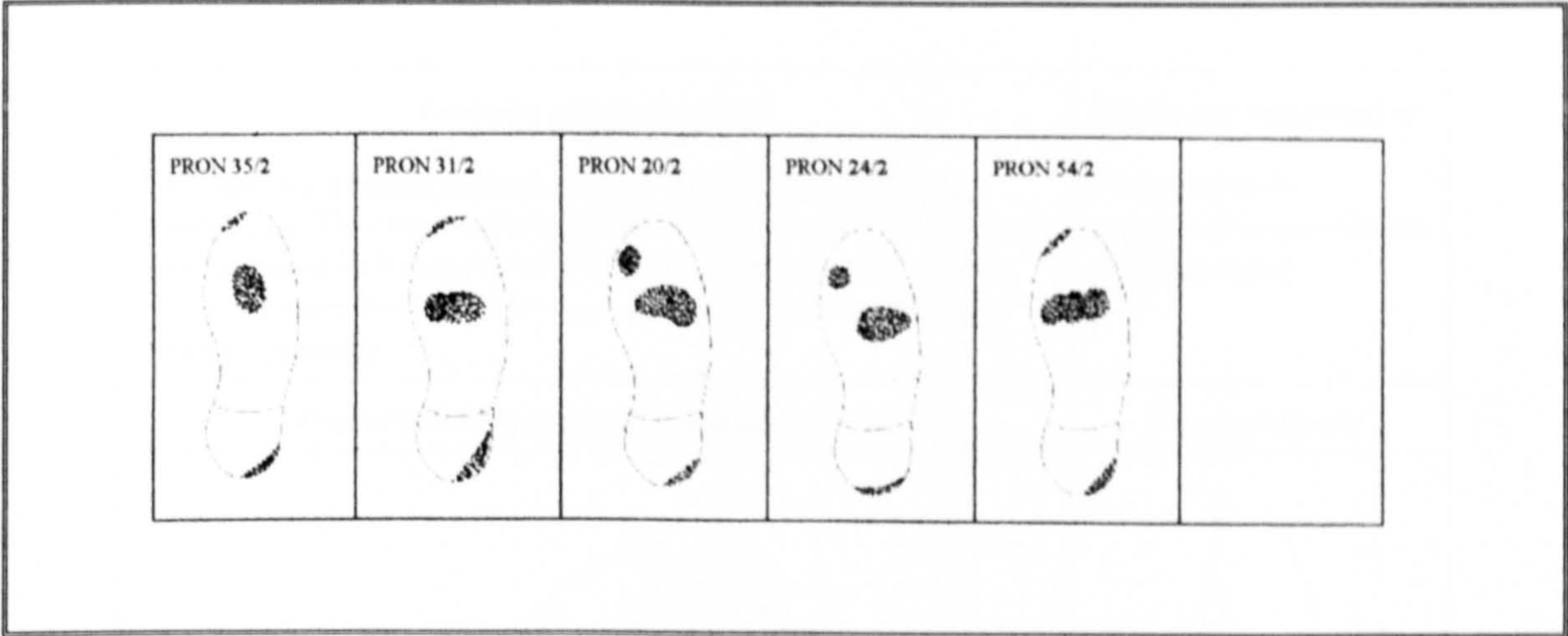
APPENDIX 19.7 Functions suggested by patterns with pronation

Function and description				Previously suggested by	
Foot contacts normally with late pronation <i>Following a normal heel strike, the foot follows a normal force pathway, but pronates rapidly towards the end of stance, with the force pathway directed medially at a late stage</i>				Not previously suggested in association with pronation	
Theoretical movements in the sagittal plane				Force pathway	
Not applicable					
Respondent patterns in support					
PRON 34/3	PRON 50/4	PRON 21/4	PRON 21/1		
					

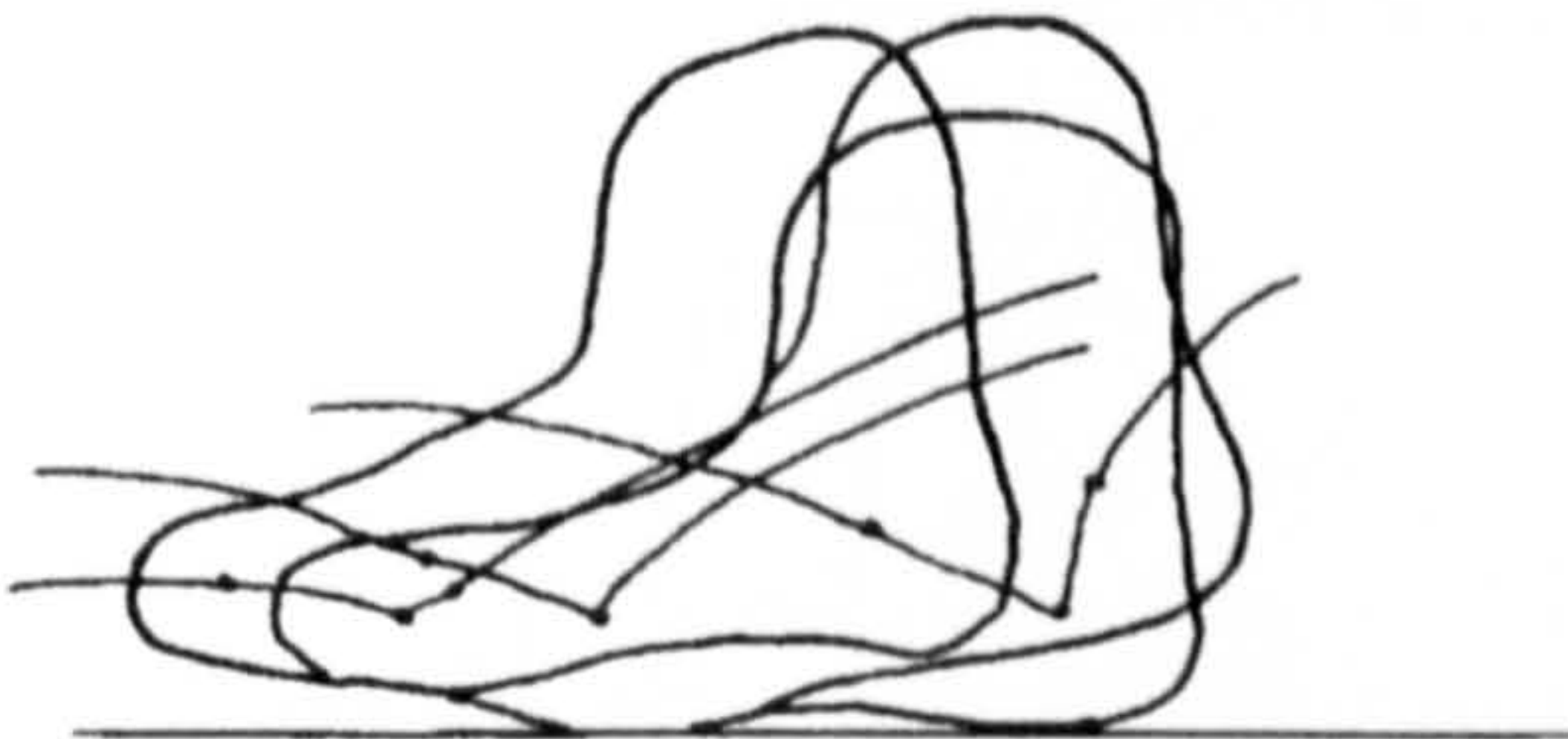








APPENDIX 19.8 Functions suggested by patterns with pronation

Function and description		Previously suggested by			
Foot contacts normally with later pronation and attempt to stabilise via functional hallux limitus Normal heel strike occurs, with later pronation occurring via the subtalar joint, directing the force pathway medially. Attempted stabilisation through functional hallux limitus prevents further medial deviation		Not previously suggested in association with pronation			
Theoretical movements in the sagittal plane		Force pathway			
					
Respondent patterns in support					
PRON 10/1	PRON 37/1	PRON 35/1	PRON 32/2	PRON 8/1	PRON 46/2
					
PRON 15/1	PRON 11/4	PRON 55/2	PRON 43/1	PRON 37/2	PRON 11/3
					

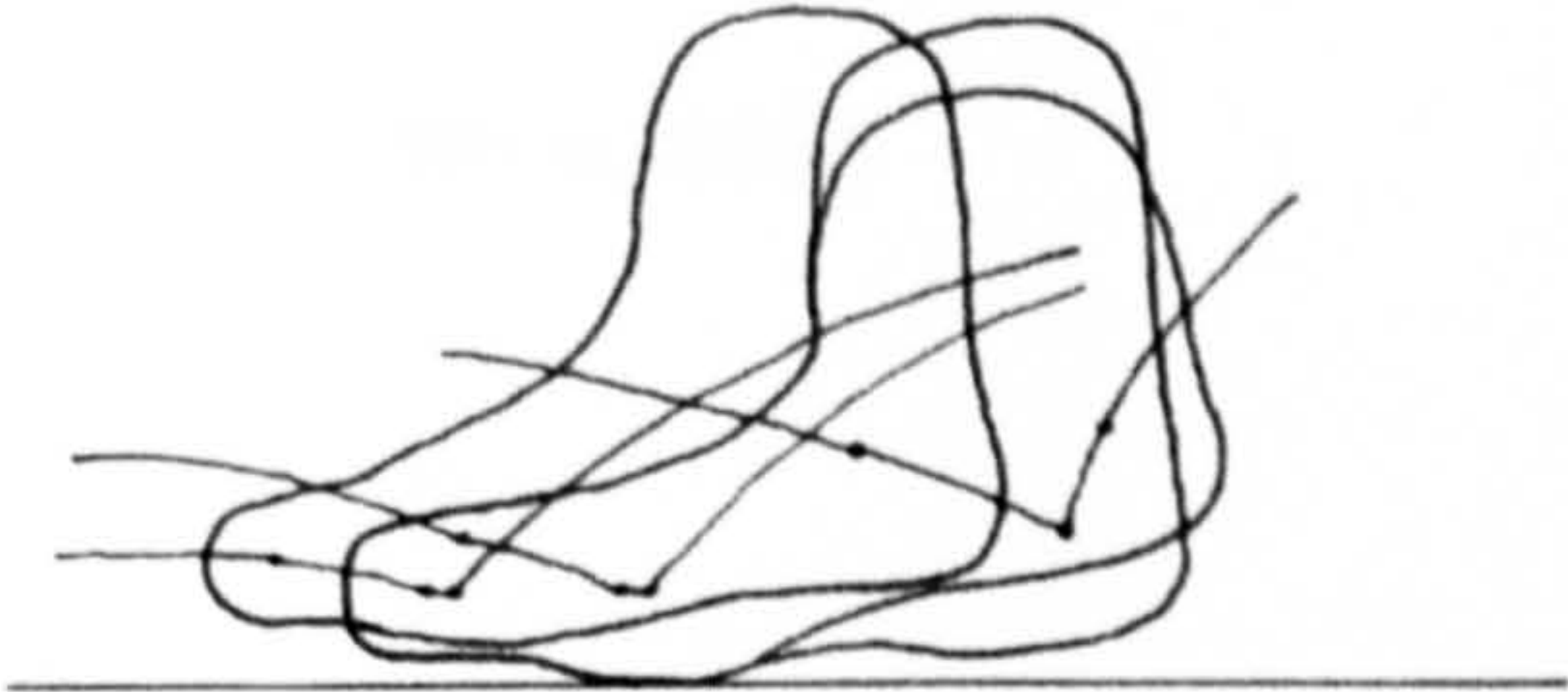






APPENDIX 19.8






APPENDIX 19.9 Functions suggested by patterns with pronation

Function and description		Previously suggested by			
<u>Heel equinus causing no heel contact and later pronation to compensate</u> <i>The restricted dorsiflexion of heel equinus results in a missed heel strike and a central force pathway. Due to this restricted dorsiflexion the foot pronates, redirecting the force pathway medially</i>		Not previously suggested in association with pronation			
Theoretical movements in the sagittal plane		Force pathway			
					
Respondent patterns in support					
PRON 45/1	PRON 47/3	PRON 5/1	PRON 47/2	PRON 32/3	PRON 6/1
					
PRON 12/2					
					










APPENDIX 19.10 Functions suggested by patterns with pronation

Function and description					Previously suggested by
<p>Heel equinus causing no heel contact and later abductory twist to compensate The restricted dorsiflexion of heel equinus results in a missed heel strike and a central force pathway. To accomodate this restricted dorsiflexion the foot undertakes an abductory twist , redirecting the force pathway medially</p>					Not previously suggested in association with pronation
Theoretical movements in the sagittal plane					Force pathway
					
Respondent patterns in support					
PRON 32/4	PRON 32/1	PRON 5/3	PRON 22/2	PRON 17/3	
					




APPENDIX 19.11 Functions suggested by patterns with pronation

Function and description		Previously suggested by			
<u>Foot lands in inversion to compensate for pronation and remains inverted throughout stance</u> <i>The foot attempts to resist the pronatory tendency by inverting before heel strike, remaining inverted throughout stance with the force pathway remaining lateral</i>		Not previously suggested in association with pronation			
Theoretical movements in the sagittal plane		Force pathway			
Not applicable					
Respondent patterns in support					
PRON 30/2	PRON 34/2				
					





APPENDIX 9.12 Functions suggested by patterns with pronation

Function and description		Previously suggested by			
The foot lands in inversion to compensate for pronation, then later pronates fully a) The foot attempts to resist the pronatory tendency by inverting before heel strike, with lateral force pathway. The foot later succumbs to the pronatory tendency with the force pathway being directed medially (Or b) vice versa – pronates to compensate for the inversion)		b) Root, Orien and Weed (p174) Neale (p44)			
Theoretical movements in the sagittal plane		Force pathway			
Not applicable					
Respondent patterns in support					
PRON 51/1	PRON 22/1	PRON 51/3	PRON 43/2	PRON 50/3	PRON 40/1
					
PRON 50/1	PRON 33/1				
					












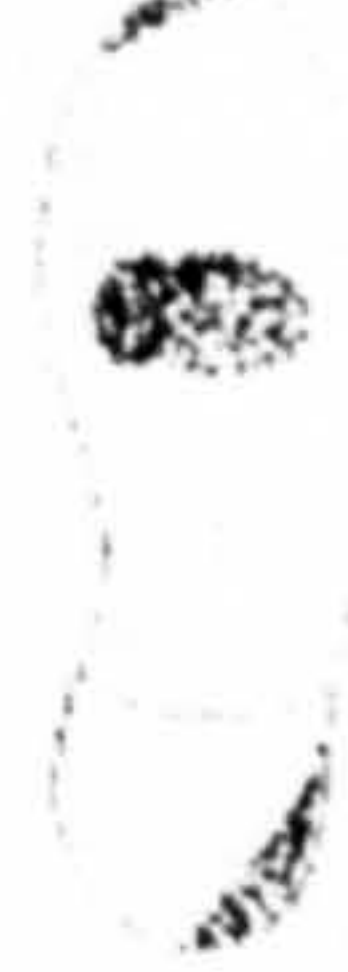

APPENDIX 19.13 Functions suggested by patterns with pronation

Function and description		Previously suggested by			
<u>The foot inverts on heel strike, then later pronates fully</u> <i>Following a normal heel strike, the foot attempts to resist the pronatory tendency by inverting, with the force pathway being directed laterally. The foot later succumbs to the pronatory tendency with the force pathway being directed medially</i>		Root, Orien and Weed (p174) Neale (p44)			
Theoretical movements in the sagittal plane		Force pathway			
Not applicable					
Respondent patterns in support					
PRON 53/1 	PRON 28/4 				


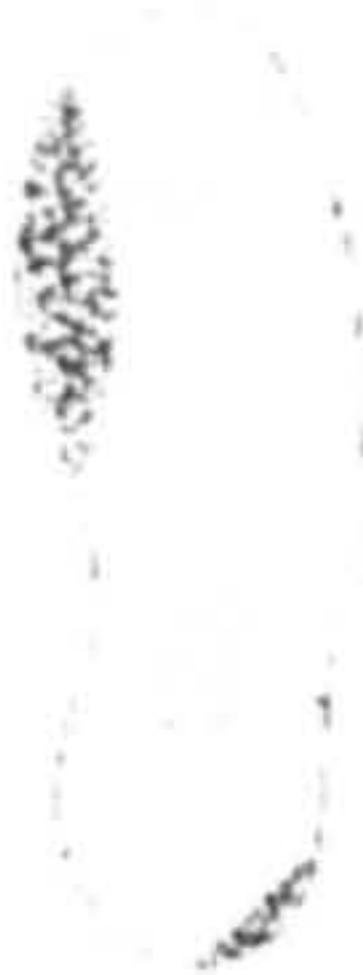











APPENDIX 19.14 Functions suggested by patterns with pronation

Function and description		Previously suggested by			
<u>Foot in fixed pronation and walking on heels in abduction with early lift</u> Due to a fixed, severe pronation, heel strike takes place with the foot abducted and the medial forefoot dorsiflexed. This directs the force pathway medially, but the foot is lifted early due to medial forefoot incompetence		Neale (p51)			
Theoretical movements in the sagittal plane		Force pathway			
					
Respondent patterns in support					
PRON 25/2	PRON 28/1				
					



















APPENDIX 19.15 Functions suggested by patterns with pronation

Function and description		Previously suggested by			
<u>Abductory twist</u> <i>Following heel strike, the foot proceeds into pronation and as the force pathway reaches the met. area, an abductory twist places the forefoot into an abducted position with subsequent rolling over the medial side of the 1st to improve the efficiency of toe-off, medially redirecting the force pathway</i>		Neale (p47)			
Theoretical movements in the sagittal plane		Force pathway			
Not applicable					
Respondent patterns in support					
PRON 42/2	PRON 8/2	PRON 16/3	PRON 35/2	PRON 43/1	PRON 37/2
					
PRON 11/3	PRON 46/1	PRON 53/2	PRON 20/2	PRON 31/2	PRON 24/2
					















APPENDIX 19.16 Functions suggested by patterns with pronation

Function and description		Previously suggested by			
<u>Foot abducted</u> <i>A marked degree of abduction accompanies pronation of the foot, with the force pathway being directed from a marked lateral heel strike, medially across the foot to a medial toe off position</i>		Root, Orien and Weed (p422) Neale (p47)			
Theoretical movements in the sagittal plane		Force pathway			
Not applicable					
Respondent patterns in support					
PRON 11/1	PRON 34/4	PRON 7/1	PRON 23/1	PRON 30/1	PRON 44/1
					
PRON 9/1	PRON 52/2	PRON 14/1	PRON 36/1	PRON 7/2	PRON 1/1
					














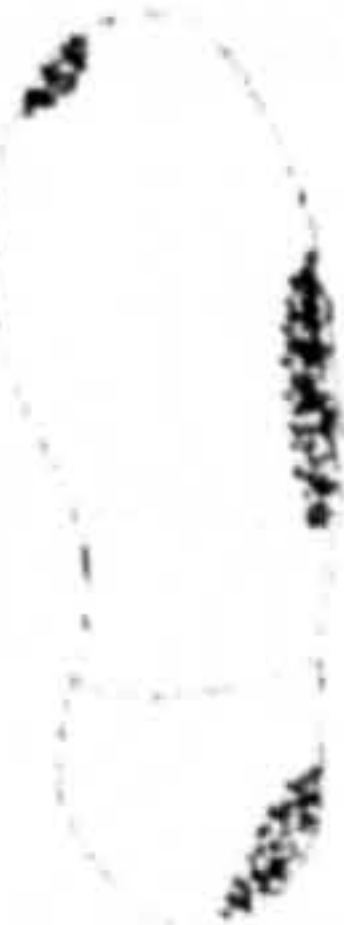





APPENDIX 19.16 – contd.

Respondent patterns in support					
PRON 51/1	PRON 22/1	PRON 15/1	PRON 37/1	PRON 35/1	PRON 35/3
					
PRON 8/1	PRON 38/1	PRON 40/1	PRON 50/1	PRON 31/2	PRON 54/2
					
PRON 43/1	PRON 35/2	PRON 37/2	PRON 11/3	PRON 50/3	PRON 33/2
					



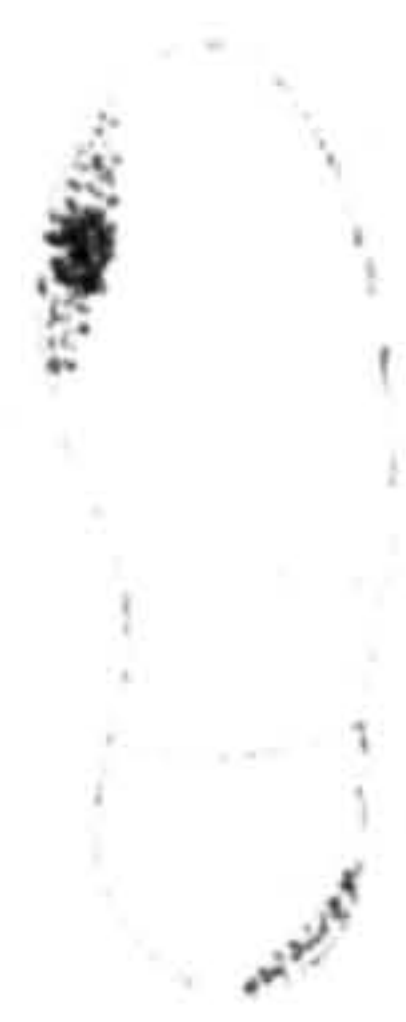










APPENDIX 20.1 Functions suggested by patterns with hallux rigidus

Function and description		Previously suggested by			
<u>Classic hallux rigidus function</u> 5th MPJt and distal aspect of 1st toe form axis as lack of movement in the 1st MPJt prevents 1st toe from dorsiflexing. This directs the pathway laterally. The force pathway therefore meets and is diverted laterally by the H. Rig. pathology.		Charlesworth (p597) Hanby and Walker (p159) Lucock			
Theoretical movements in the sagittal plane		Force pathway			
					
Respondent patterns in support					
HR 4/1	HR 6/1	HR 8/1	HR 12/1	HR 16/1	HR 20/1
					
HR 24/1	HR 26/1	HR 27/1	HR 28/1	HR 29/1	HR 33/1
					

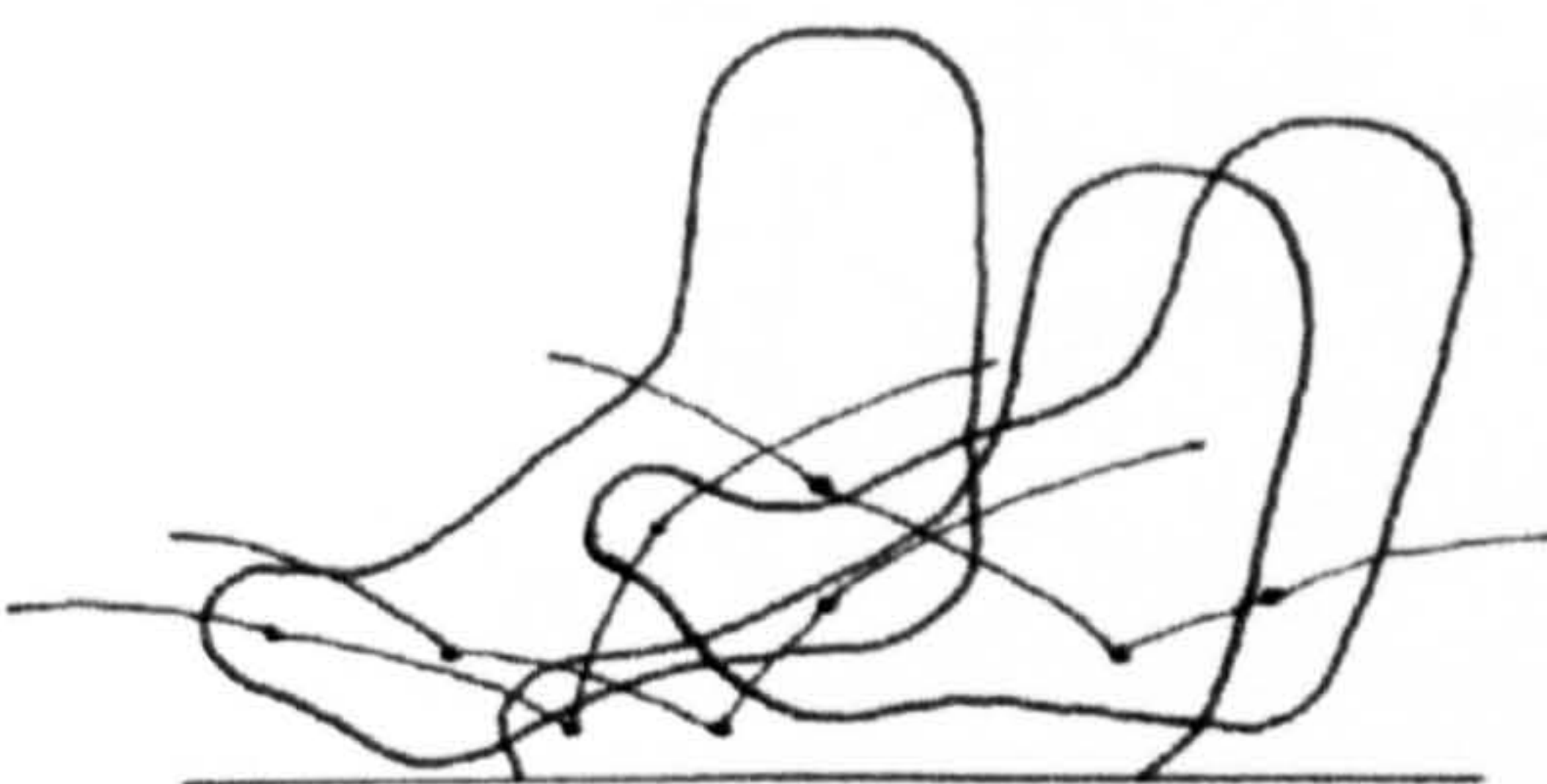







APPENDIX 20.1 – contd.

Respondent patterns in support (contd.)					
HR 34/1	HR 37/1	HR 38/1	HR 39/1	HR 42/1	HR 44/1
					
HR 45/1	HR 54/1	HR 55/1	HR 16/2	HR 51/2	HR 25/2
					
HR 51/2	HR 42/2	HR 51/2	HR 26/2	HR 29/2	HR 20/2
					
HR 55/2					
					














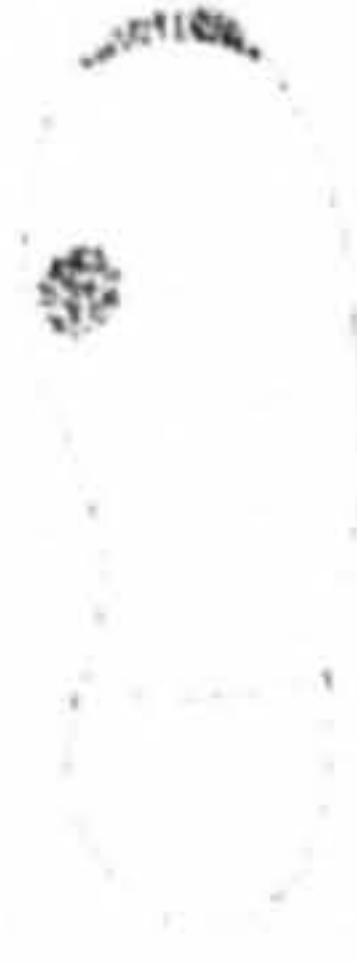
APPENDIX 20.2 Functions suggested by patterns with hallux rigidus

Function and description		Previously suggested by			
<u>Abducted gait</u> <i>As the feet are directed out, the force pathway passes medially over the 1st MPJt with the 1st therefore not requiring dorsiflexing due to foot "rolling" off the medial side of the 1st toe and MPJt instead.</i>		Rzonka Sherman			
Theoretical movements in the sagittal plane		Force pathway			
					
Respondent patterns in support					
HR 2/1	HR 3/1	HR 11/1	HR 13/1	HR 22/1	HR 31/1
					
HR 41/1	HR 48/1	HR 50/1	HR 51/1	HR 32/4	
					






APPENDIX 20.3 Functions suggested by patterns with hallux rigidus

Function and description		Previously suggested by			
<u>Pronation with abducted gait</u> <i>Heel strike <u>may</u> be on medial heel aspect. As with abducted gait, with the feet being directed out, the force pathway passes medially over the 1st MPJt with the 1st therefore not requiring dorsiflexing due to the foot "rolling" off the medial side of the 1st toe and MPJt instead.</i>		Dananberg (refers to pronation but not abduction) Sherman			
Theoretical movements in the sagittal plane		Force pathway			
					
Respondent patterns in support					
HR 14/3	HR 17/2	HR 19/1	HR 48/3	HR 12/2	HR 31/2
					









APPENDIX 20.4 Functions suggested by patterns with hallux rigidus

Function and description		Previously suggested by			
<u>No medial or lateral deviation from normal gait pathway (with or without hyperextension of 1st MPJt)</u> <i>Lack of medial/lateral deviation gives normally appearing force pathway when viewed from above, but deviating pathway when viewed horizontally.</i> <i>Hyperextended distal phalanx of 1st toe will be present.</i>		Rzonka Root, Orien and Weed (p369)			
Theoretical movements in the sagittal plane	Force pathway				
					
Respondent patterns in support					
HR 7/1	HR 9/1	HR 10/1	HR 17/1	HR 18/1	HR 25/1
					
HR 30/1	HR 32/1	HR 40/1	HR 49/1	HR 53/1	HR 14/2
					



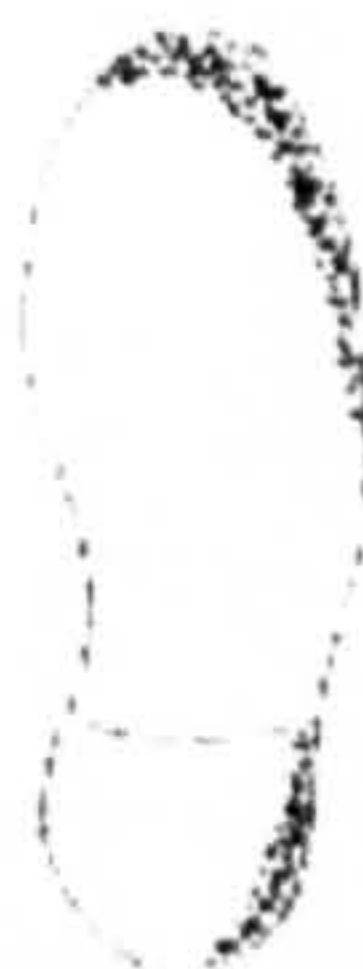



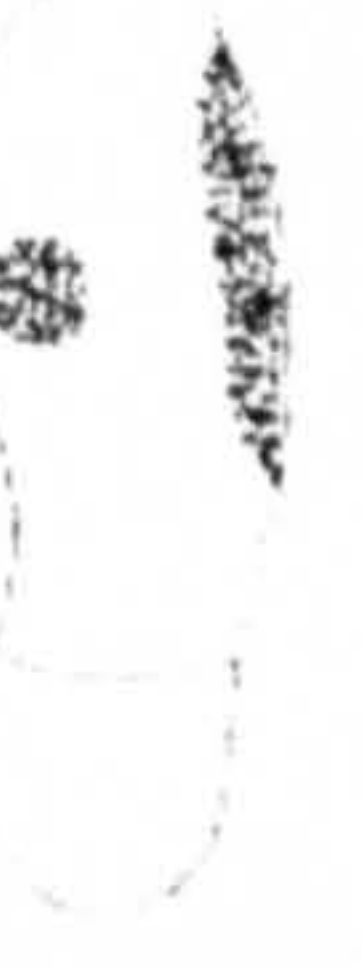
APPENDIX 20.4 - contd.

Respondent patterns in support					
HR 11/3	HR 14/1	HR 5/2	HR 8/2	HR 36/1	
					



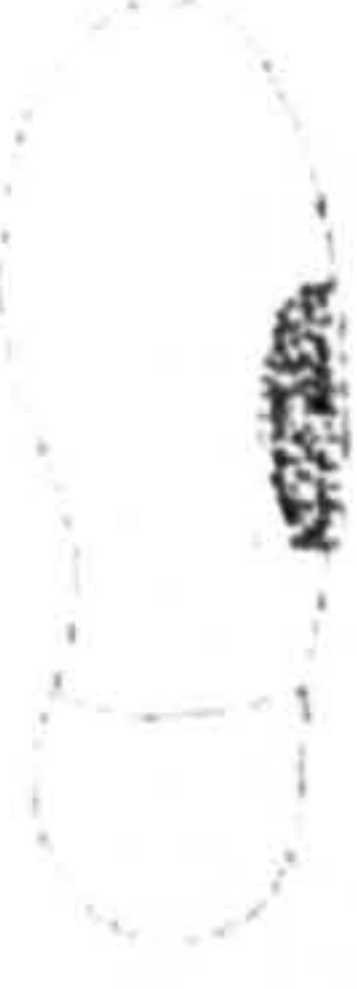
APPENDIX 20.5 Functions suggested by patterns with hallux rigidus

Function and description		Previously suggested by			
<u>Abductory twist</u> <i>As the force pathway reaches the met. area, an abductory twist places the forefoot into an abducted position with subsequent rolling over the medial side of the 1st preventing the need for the 1st to dorsiflex.</i>		Not previously suggested in association with hallux rigidus			
Theoretical movements in the sagittal plane		Force pathway			
Not applicable					
Respondent patterns in support					
HR 36/1 	HR 51/1 	HR 52/1 	HR 23/1 	HR 32/2 	HR 46/2 
HR 50/2 					



APPENDIX 20.6 Functions suggested by patterns with hallux rigidus

Function and description		Previously suggested by			
<u>Compensatory supination/inversion of the foot</u> <i>Uncompensated calcaneal inversion keeps the force pathway lateral therefore avoiding the limitation in dorsiflexion of the 1st caused by the H. Rig.</i>		Neale (p64) Turchin Rzonka Sherman			
Theoretical movements in the sagittal plane		Force pathway			
Not applicable					
Respondent patterns in support					
HR 33/1	HR 54/1	HR 5/3	HR 11/2	HR 53/2	HR 31/3
					



APPENDIX 20.7 Functions suggested by patterns with hallux rigidus

Function and description		Previously suggested by			
<u>Forefoot inversion</u> <i>Normal heel strike occurs. As inverted forefoot is met, the force pathway remains lateral, therefore avoiding the limitations in dorsiflexion of the 1st caused by the H. Rig.</i>		Dananberg Rzonka			
Theoretical movements in the sagittal plane		Force pathway			
Not applicable					
Respondent patterns in support					
HR 21/1	HR 32/3				
					




APPENDIX 20.8 Functions suggested by patterns with hallux rigidus

Function and description		Previously suggested by			
<u>Abducted gait with eversion</u> <i>Everted calc. plus abducted foot results in medial heel strike from which propulsion is gained with only slight assistance from 1st toe, avoiding limitation in dorsiflexion of the 1st caused by the H. Rig. through medial pathway.</i>		Not previously suggested in association with hallux rigidus.			
Theoretical movements in the sagittal plane		Force pathway			
Not applicable					
Respondent patterns in support					
HR 17/2 					

APPENDIX 20.9 Functions suggested by patterns with hallux rigidus

Function and description		Previously suggested by			
<u>Abducted gait with eversion</u> <i>Everted calc. plus abducted foot results in medial heel strike from which propulsion is gained with only slight assistance from 1st toe, avoiding limitation in dorsiflexion of the 1st caused by the H. Rig. through medial pathway.</i>		Not previously suggested in association with hallux rigidus.			
Theoretical movements in the sagittal plane		Force pathway			
Not applicable					
Respondent patterns in support					
HR 17/2 					



APPENDIX 20.10 Functions suggested by patterns with hallux rigidus

Function and description		Previously suggested by			
<u>Adducted gait</u> <i>Medial heel strike, possibly with calcaneo-valgus results in force pathway passing laterally across the foot avoiding for need for the 1st to dorsiflex through this lateral deviation with resultant toe off from lateral aspect of the forefoot.</i>		Not previously suggested in association with hallux rigidus			
Theoretical movements in the sagittal plane		Force pathway			
Not applicable					
Respondent patterns in support					
HR 46/1	HR 48/4				
					

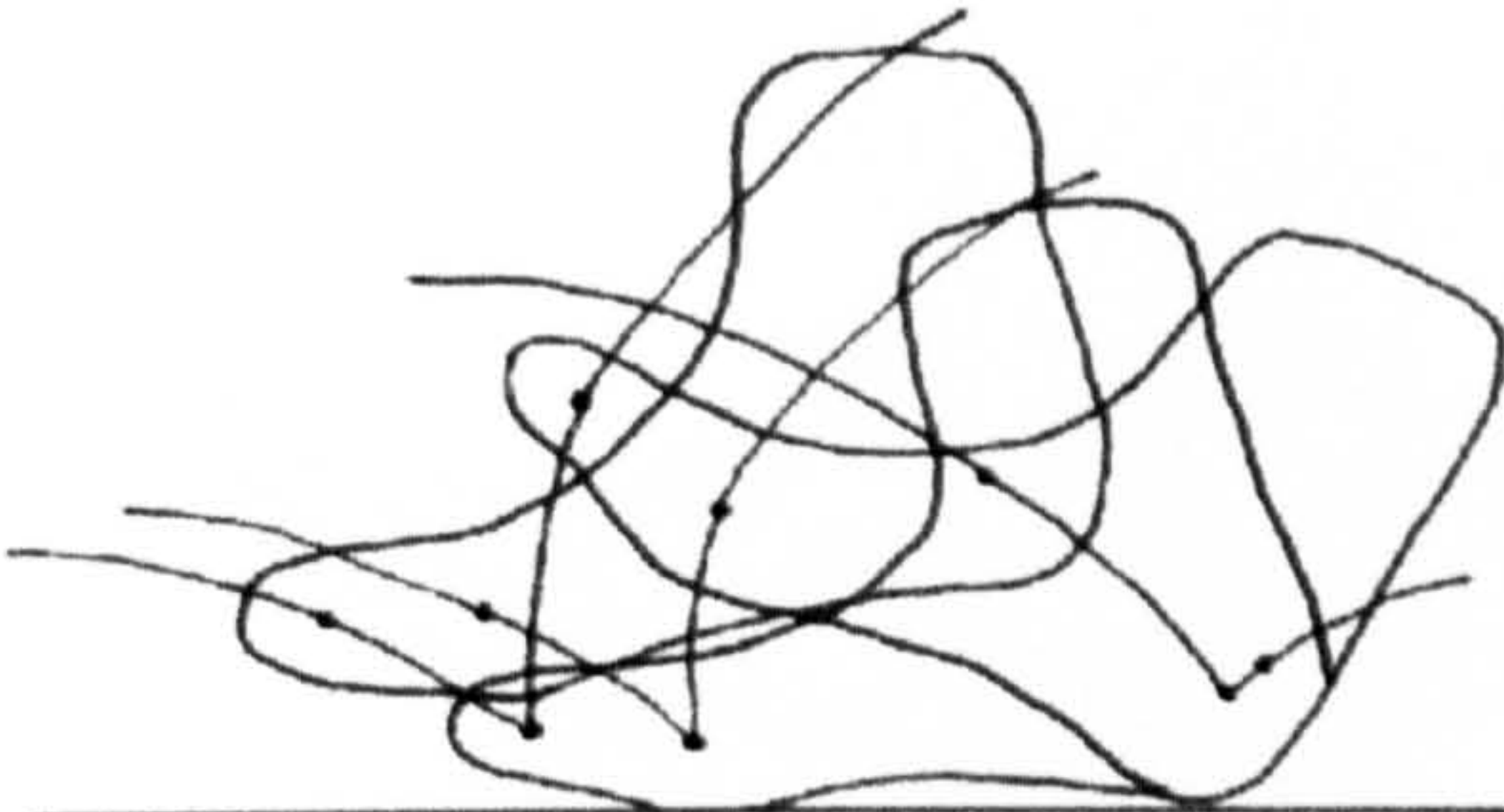


APPENDIX 20.11 Functions suggested by patterns with hallux rigidus

Function and description		Previously suggested by			
<u>Stamping gait</u> <i>The foot "stamps" down and vertically lifts, therefore eliminating the need for dorsiflexion of the 1st toe.</i>		Not previously suggested in association with hallux rigidus			
Theoretical movements in the sagittal plane		Force pathway			
Respondent patterns in support					
HR 47/1 					

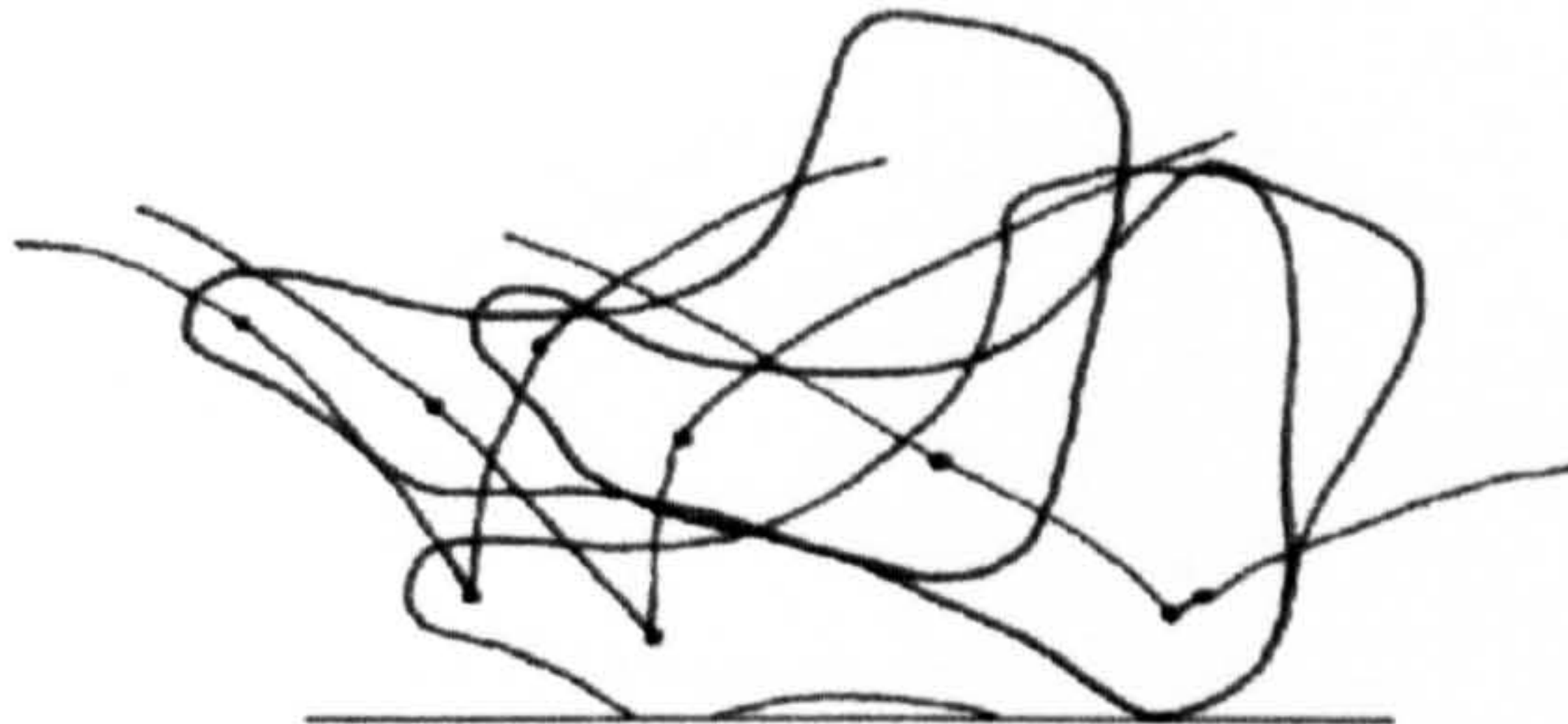


APPENDIX 20.12 Functions suggested by patterns with hallux rigidus

Function and description					Previously suggested by
<p><u>Adductory twist</u> <i>As the pathway reaches the met. area, an adductory twist places the forefoot into the adducted position with subsequent lateral progress of the force pathway, preventing the need for the 1st to dorsiflex through this lateral deviation with resultant toe off from lateral aspect of the forefoot.</i></p>					Not previously suggested in association with hallux rigidus
Theoretical movements in the sagittal plane					Force pathway
Not applicable					
Respondent patterns in support					
<div> <div>HIR 55/2</div>  </div>					

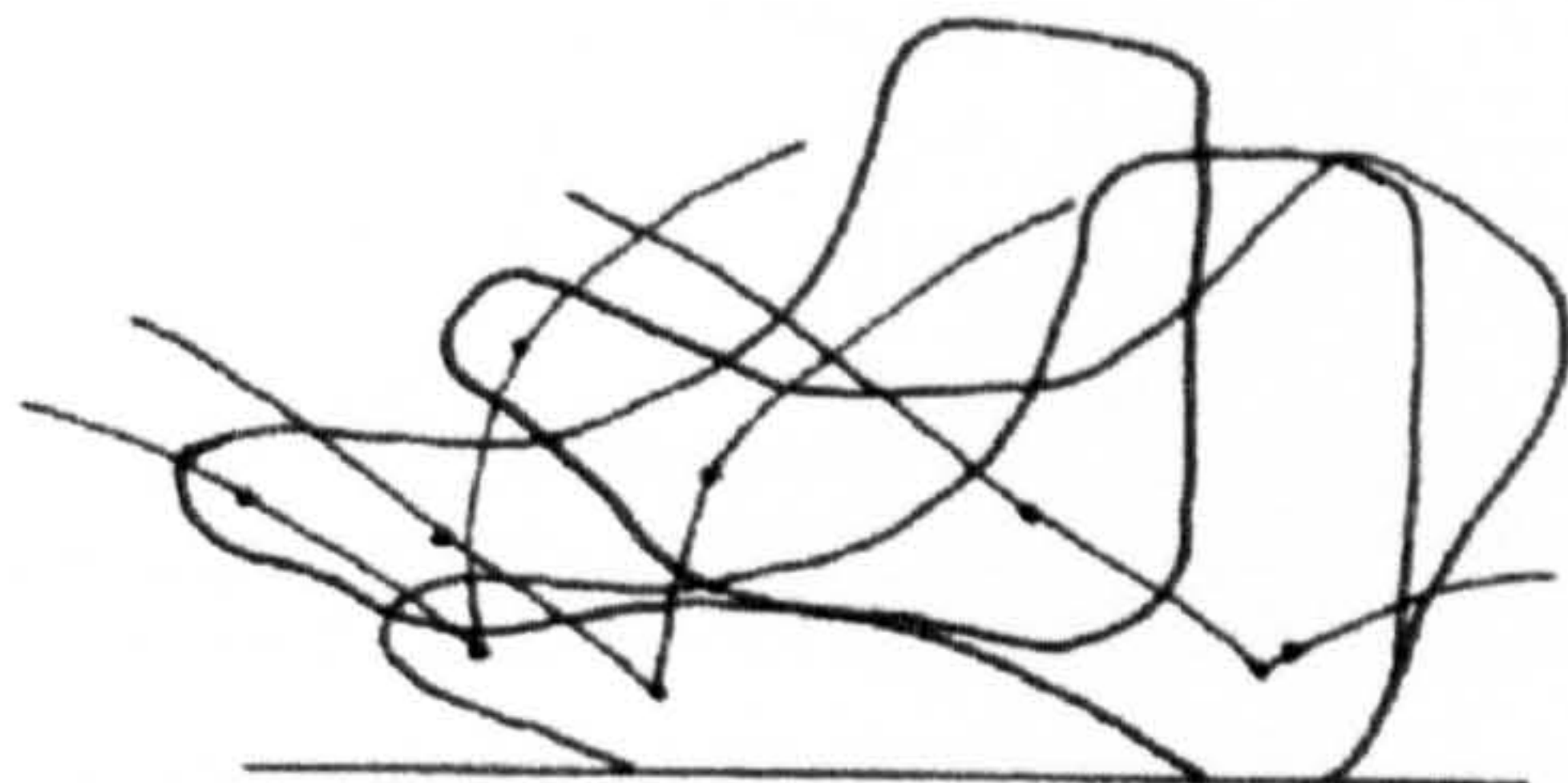


APPENDIX 20.13 Functions suggested by patterns with hallux rigidus

Function and description		Previously suggested by			
<u>Calcaneal gait</u> <i>Through a lax tendo-achilles, dorsiflexion is taken up by the ankle. This may subsequently lead to vertical toe off, possibly with scuffing of the toes.</i>		Not previously suggested in association with hallux rigidus			
Theoretical movements in the sagittal plane		Force pathway			
					
Respondent patterns in support					
HR 32/4 					

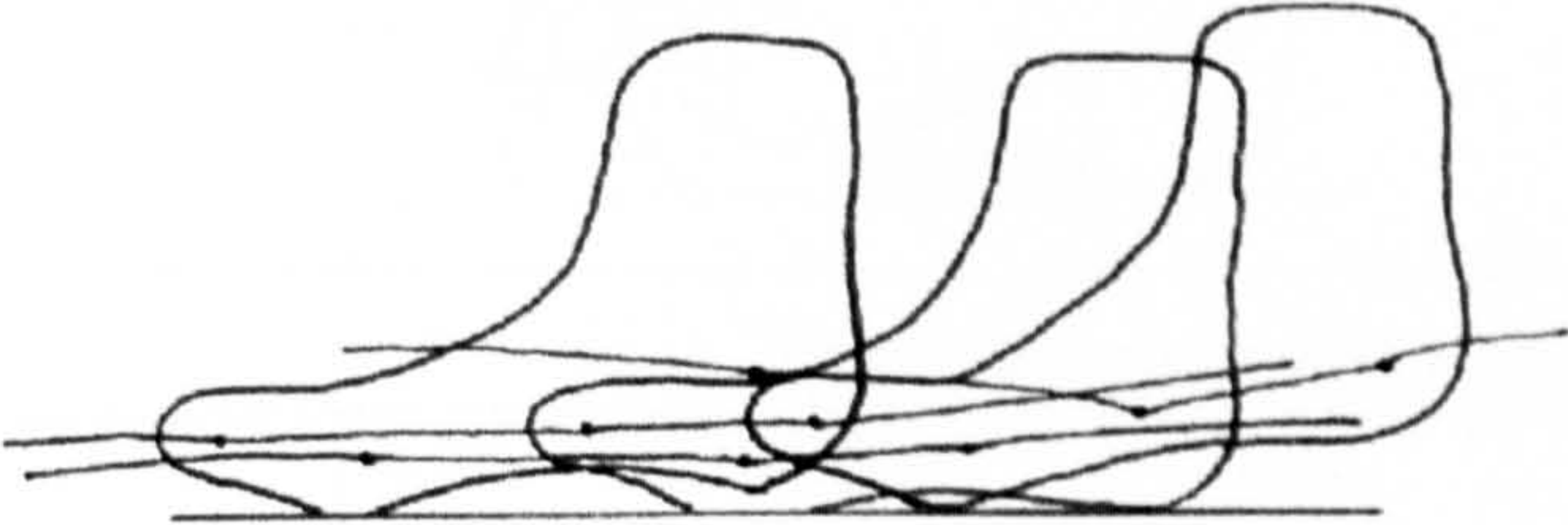

APPENDIX 20.14 Functions suggested by patterns with hallux rigidus

Function and description				Previously suggested by	
<u>Walking predominately on heels</u> <i>Similar to calcaneal gait, but without excess ankle dorsiflexion. Weight bearing is on the heels with minimal or no forefoot contact and vertical lift off prevents the need for 1st dorsiflexion.</i>				Not previously suggested in conjunction with hallux rigidus	
Theoretical movements in the sagittal plane				Force pathway	
					
Respondent patterns in support					
HR 32/4 					















APPENDIX 20.15 Functions suggested by patterns with hallux rigidus

Function and description		Previously suggested by			
Vertical toe-off <i>Normal gait cycle until 1st MPJt restriction is encountered, when the foot lifts vertically.</i>		Dananberg Rzonka Root, Orien and Weed (p367)			
Theoretical movements in the sagittal plane		Force pathway			
					
Respondent patterns in support					
HR 47/1 					




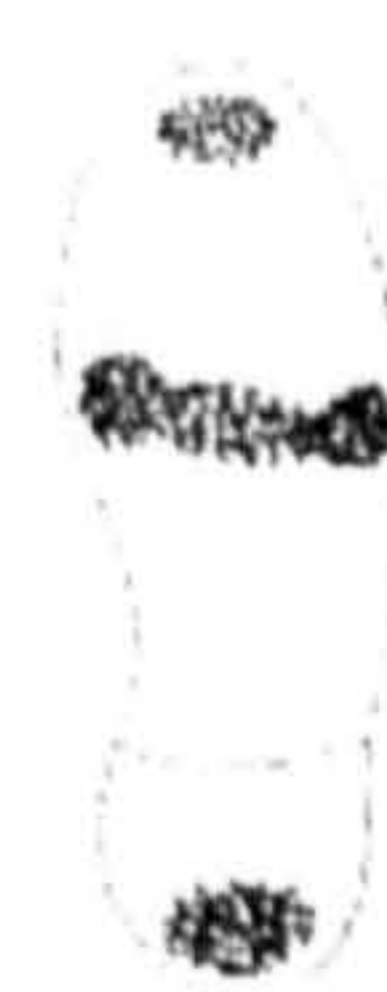












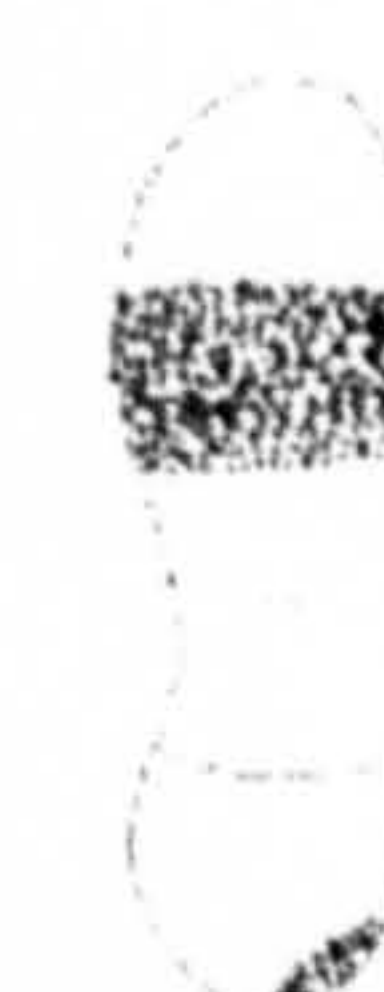



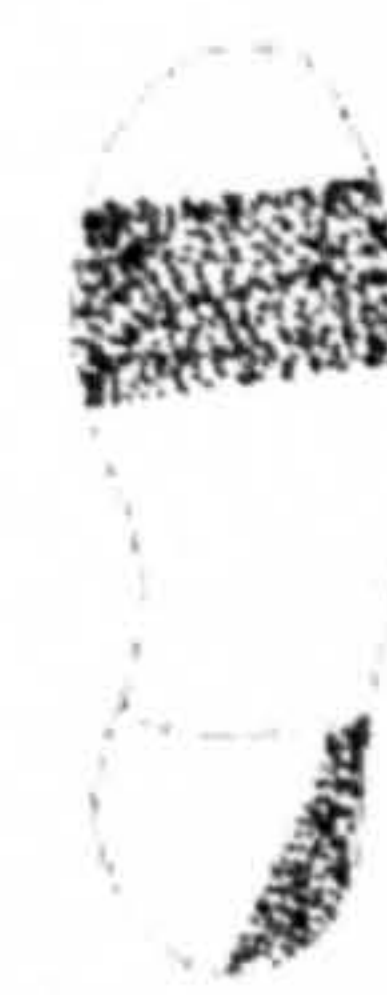



APPENDIX 20.16 Functions suggested by patterns with hallux rigidus

Function and description					Previously suggested by
<u>Shuffling gait</u> Feet strike ground in predominately horizontally directed movement, abrading as they strike. This extreme inhibition of vertical movement eliminates the need for the 1st to dorsiflex.					Not previously suggested in association with hallux rigidus
Theoretical movements in the sagittal plane					Force pathway
					
Respondent patterns in support					
Not observed in returned patterns					


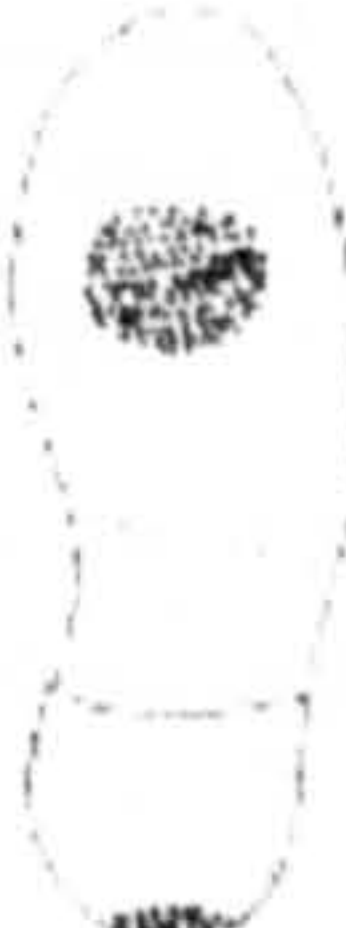






APPENDIX 21.1 Functions suggested by patterns with pes cavus

Function and description		Previously suggested by			
<u>Normal force pathway with increased forefoot loading and no toe-off propulsion due to pes cavus</u> <i>Normal heel strike and normally directed force pathway with weight-bearing dissipated at the forefoot and without toe-off due to retracted toes.</i>		Neale (p53)			
Theoretical movements in the sagittal plane		Force pathway			
					
Respondent patterns in support					
PC 45/1	PC 26/1	PC 13/1	PC 23/1	PC 43/1	PC 53/1
					
PC 18/2	PC 24/2	PC 42/1	PC 19/1	PC 51/2	PC 2/2
					















APPENDIX 21.1 – contd.

Respondent patterns in support (contd.)					
PC 26/3	PC 16/1	PC 55/2	PC 29/3	PC 15/1	PC 33/1
					
PC 27/1	PC 42/2	PC 18/1	PC 13/2	PC 36/1	PC 17/1
					
PC 11/1	PC 44/1	PC 41/1	PC 37/1	PC 48/3	PC 20/2
					
PC 54/2	PC 50/1	PC 25/2	PC 55/1	PC 1/1	PC 8/2
					





APPENDIX 21.1 – contd.

Respondent patterns in support (contd.)					
PC 6/2	PC 42/3	PC 7/2	PC 24/1	PC 8/3	PC 29/2
					
PC 43/2	PC 26/2				
					

APPENDIX 21.2 Functions suggested by patterns with pes cavus

Function and description		Previously suggested by			
<u>Normal force pathway with forefoot loading and no toe-off propulsion due to pes cavus and without heel strike due to dropped forefoot</u> <i>No heel strike due to position of heel in relation to forefoot and normally directed force pathway with weight-bearing dissipated at the forefoot and without toe-off due to retracted toes.</i>		Not previously suggested in association with pes cavus			
Theoretical movements in the sagittal plane		Force pathway			
					
Respondent patterns in support					
PC 46/2	PC 7/1	PC 14/1	PC 5/1	PC 5/2	PC 22/1
					
PC 46/1	PC 54/3	PC 5/3	PC 14/2	PC 1/3	PC 27/2
					







APPENDIX 21.2 – contd.

Respondent patterns in support					
PC 10/1	PC 38/1	PC 30/1	PC 13/3		
					






APPENDIX 21.3 Functions suggested by patterns with pes cavus

Function and description					Previously suggested by
<u>Foot inverted throughout stance</u> <i>Lateral heel strike due to inversion of the foot, maintained throughout stance hence with laterally positioned force pathway</i>					Not previously suggested in association with pes cavus
Theoretical movements in the sagittal plane					Force pathway
Not applicable					
Respondent patterns in support					
PC 34/2	PC 52/1	PC 51/4	PC 28/2	PC 31/1	









APPENDIX 21.4 Functions suggested by patterns with pronation

Function and description					Previously suggested by
Foot inverted and abducted throughout stance <i>Lateral heel strike, accentuated through concurrent abduction of the foot maintained throughout stance hence with laterally positioned force pathway</i>					Not previously suggested in association with pes cavus
Theoretical movements in the sagittal plane					Force pathway
Not applicable					
Respondent patterns in support					
PC 34/2 	PC 52/1 	PC 51/4 	PC 28/2 	PC 31/1 	














APPENDIX 21.5 Functions suggested by patterns with pes cavus

Function and description				Previously suggested by	
<u>Foot inverted on heel strike, normal force pathway at forefoot</u> <i>Lateral heel strike due to inversion of the heel with lateral force pathway which shifts centrally to assume normal inclination of forefoot.</i>				(Neale p. 51)	
Theoretical movements in the sagittal plane				Force pathway	
Not applicable					
Respondent patterns in support					
PC 6/1	PC 25/1	PC 33/2	PC 4/1		
					



APPENDIX 21.6 Functions suggested by patterns with pes cavus

Function and description						Previously suggested by
<u>Normal heel strike, inverted forefoot</u> <i>From normal heel strike, the foot inverts with the force pathway passing laterally</i>						Root, Orien and Weed (p263) Neale (p37)
Theoretical movements in the sagittal plane						Force pathway
Not applicable						
Respondent patterns in support						
PC 49/1	PC 21/1	PC 31/3	PC 15/2	PC 8/1	PC 24/3	
						
PC 20/1						
						




APPENDIX 21.7 Functions suggested by patterns with pes cavus

Function and description		Previously suggested by			
Normal or inverted heel, everted forefoot <i>Normal or slightly inverted heel strike occurs. As functionally everted forefoot is met, the force pathway passes medially</i>		Neale (p37, p51)			
Theoretical movements in the sagittal plane		Force pathway			
Not applicable					
Respondent patterns in support					
PC 12/2	PC 39/1	PC 1/2	PC 32/1	PC 3/1	PC 54/1
					
PC 28/3	PC 48/2	PC 48/1	PC 2/1	PC 48/4	PC 28/1
					



APPENDIX 21.7 – contd.

Respondent patterns in support					
PC 34/1	PC 9/1				
					







APPENDIX 21.8 Functions suggested by patterns with pes cavus

Function and description		Previously suggested by			
<u>Everted heel and forefoot</u> <i>Eversion of the heel results in medially inclined heel strike maintained into the forefoot with medial force pathway throughout.</i>		Neale (p37).			
Theoretical movements in the sagittal plane		Force pathway			
Not applicable					
Respondent patterns in support					
PC 12/3	PC 51/3				
					



APPENDIX 21.9 Functions suggested by patterns with pes cavus

Function and description					Previously suggested by
<u>Everted heel, inverted forefoot</u> <i>Medial heel strike from the everted heel results in force pathway passing laterally across the foot where it is counteracted by the inverted forefoot</i>					
Theoretical movements in the sagittal plane					Force pathway
Not applicable					
Respondent patterns in support					
PC 35/1 					

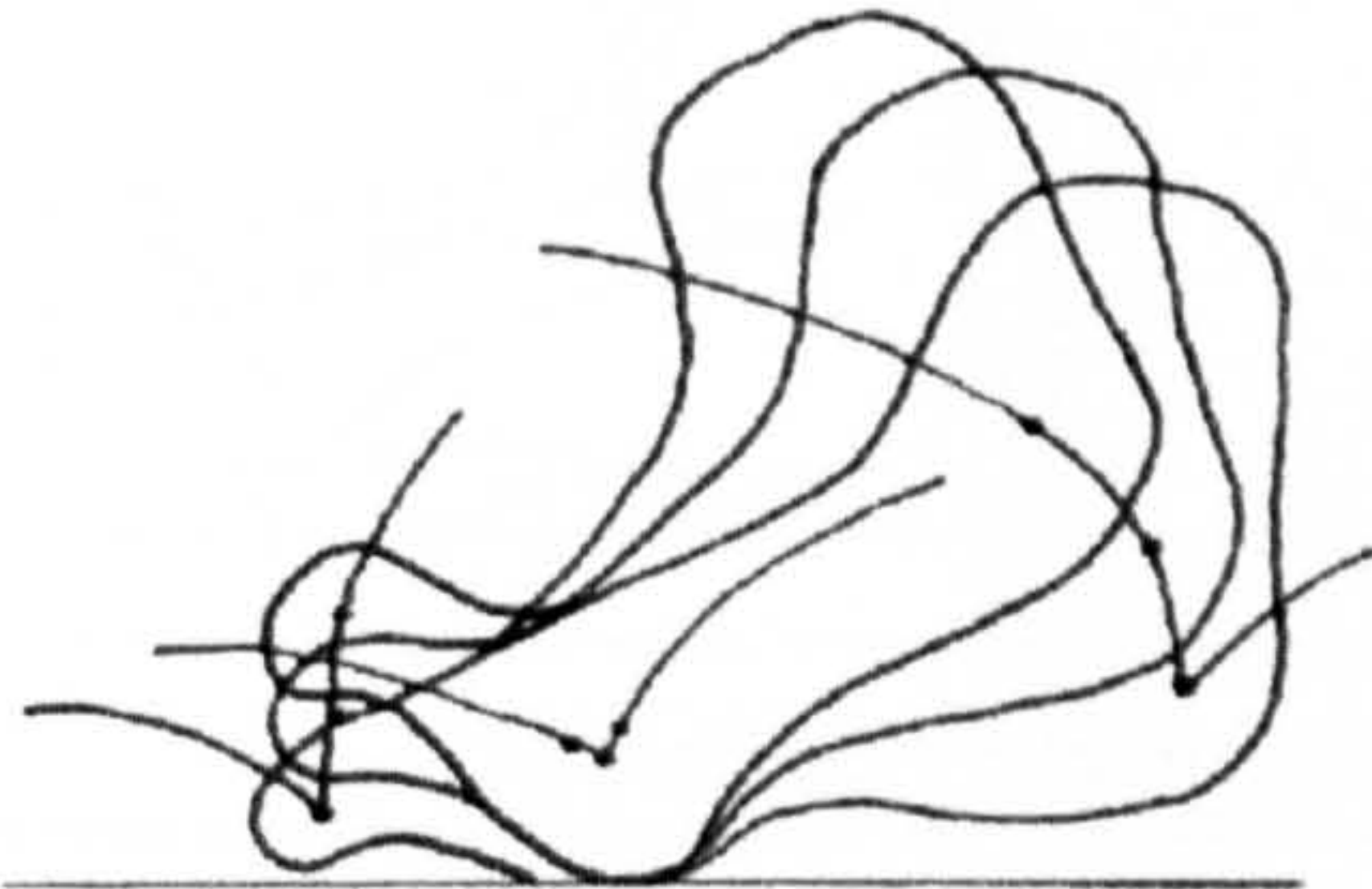


APPENDIX 21.10 Functions suggested by patterns with pes
cavus

Function and description					Previously suggested by
<u>Feet abducted</u> <i>Abduction of the foot leads to lateral heel strike, with force pathway passing medially across prominent 1st MPJt area</i>					Not previously suggested in association with pes cavus
Theoretical movements in the sagittal plane					Force pathway
Not applicable					
Respondent patterns in support					
PC 12/2	PC 39/1	PC 32/1	PC 28/1	PC 48/4	
					

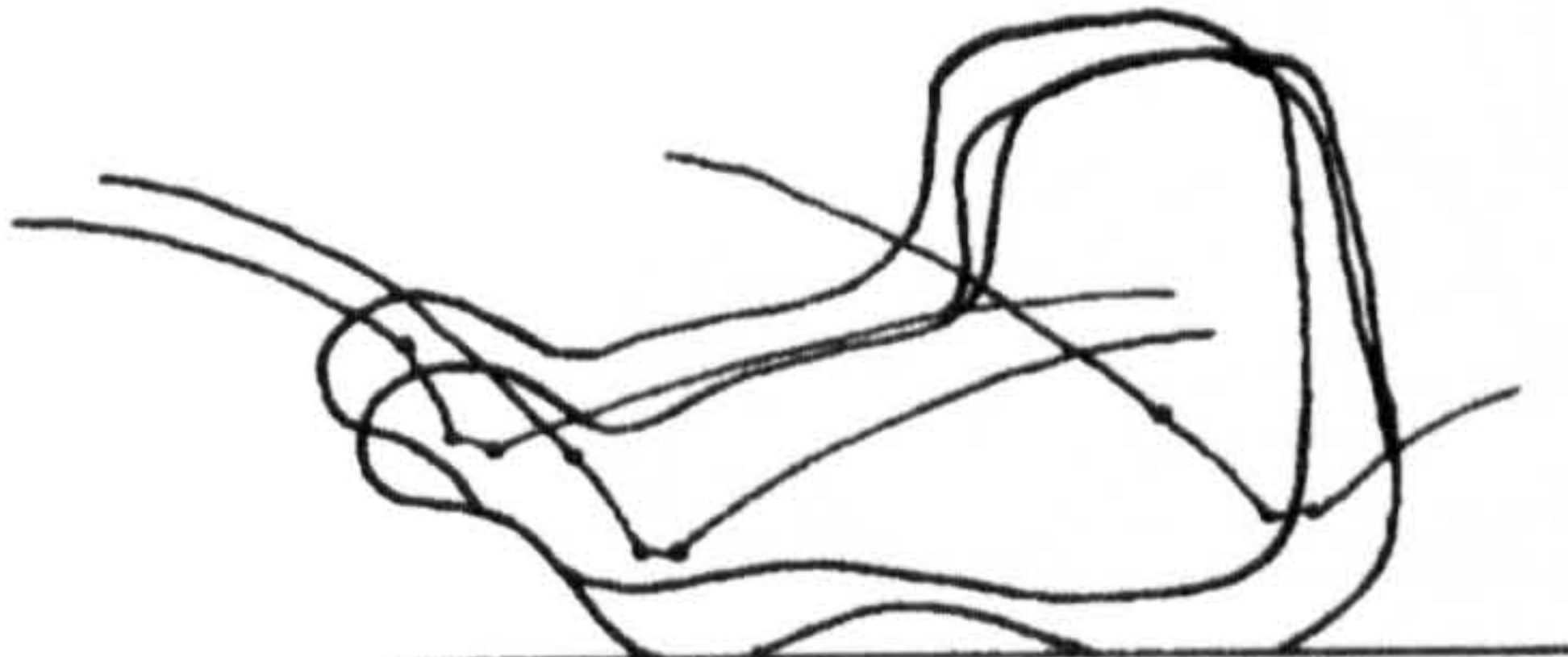



APPENDIX 21.11 Functions suggested by patterns with pes
cavus

Function and description				Previously suggested by	
<u>Feet Adducted</u> <i>Medial heel strike due to adducted position of foot with force pathway passing laterally across prominent 5th MPJt area</i>				Not previously suggested in association with pes cavus	
Theoretical movements in the sagittal plane				Force pathway	
Not applicable					
Respondent patterns in support					
PC 35/1 					

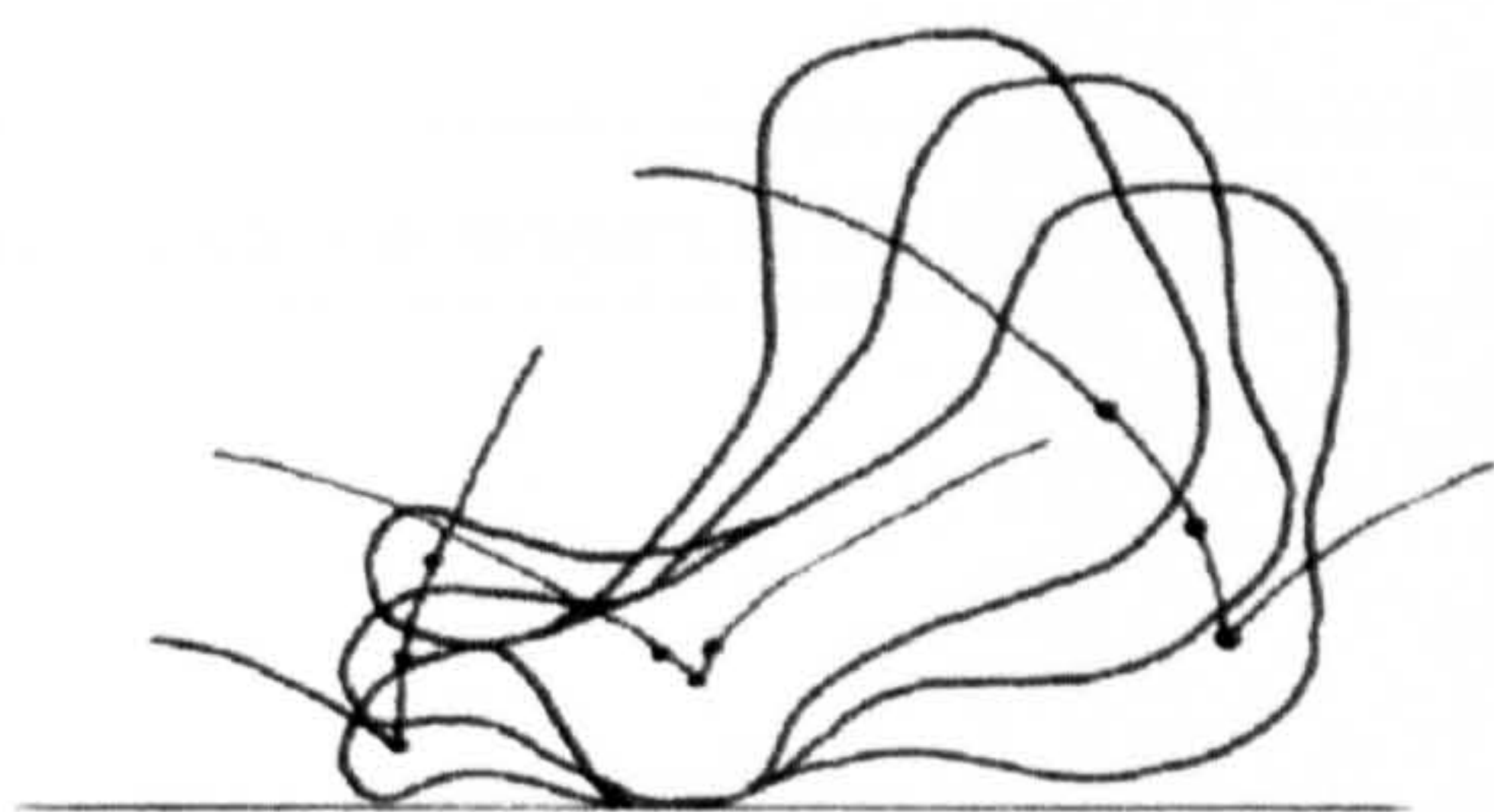




APPENDIX 21.12 Functions suggested by patterns with pes cavus

Function and description						Previously suggested by
<p>No heel strike due to dropped forefoot and inverted forefoot</p> <p><i>Prominent inverted forefoot with limited dorsiflexion restricts heel strike and inversion of forefoot gives laterally inclined force pathway</i></p>						Not previously suggested in association with pes cavus
Theoretical movements in the sagittal plane						Force pathway
						
Respondent patterns in support						
PC 32/2 						





APPENDIX 21.13 Functions suggested by patterns with pes
cavus

Function and description		Previously suggested by			
<u>Dorsiflexion of foot with load bearing (heavily) on heel</u> <i>Foot dorsiflexed at heel strike with force pathway avoiding prominent MPJt area and foot lifted vertically avoiding toe off</i>		Neale (p36)			
Theoretical movements in the sagittal plane		Force pathway			
					
Respondent patterns in support					
PC 39/2	PC 40/1				
					



APPENDIX 21.14 Functions suggested by patterns with pes cavus

Function and description		Previously suggested by			
<u>No heel strike due to dropped forefoot and everted forefoot</u> <i>Prominent inverted forefoot with limited dorsiflexion restricts heel strike and eversion of forefoot gives medially inclined force pathway</i>		Not previously suggested in association with pes cavus			
Theoretical movements in the sagittal plane		Force pathway			
					
Respondent patterns in support					
PC 47/3	PC 47/4	PC 51/1			
					

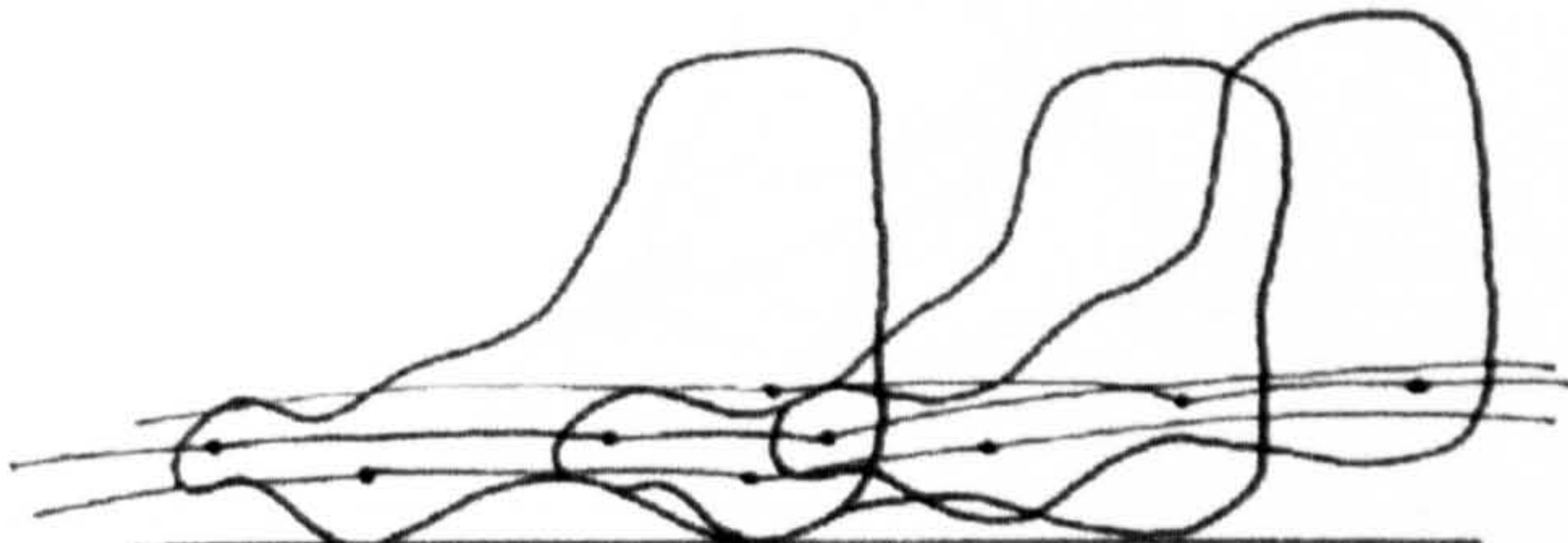


APPENDIX 21.15 Functions suggested by patterns with pes cavus

Function and description			Previously suggested by		
<u>Abductory twist</u> <i>Normal force pathway until prominent met. area is reached, then abductory twist directs pathway medially.</i>			Not previously suggested in association with pes cavus		
Theoretical movements in the sagittal plane			Force pathway		
Not applicable					
Respondent patterns in support					
PC 47/3	PC 47/4	PC 22/2			
					




APPENDIX 21.16 Functions suggested by patterns with pes cavus

Function and description					Previously suggested by
<u>Adductory twist</u> <i>Normal force pathway until prominent met. area is reached, then adductory twist directs pathway laterally.</i>					Not previously suggested in association with Hallux Rigidus
Theoretical movements in the sagittal plane					Force pathway
Not applicable					
Respondent patterns in support					
PC 53/2 					














APPENDIX 21.17 Functions suggested by patterns with pes cavus

Function and description		Previously suggested by			
<u>Shuffling Gait</u> <i>Foot strikes ground in predominately horizontally directed movement, abrading the outsole with this strike.</i>		Not previously suggested in association with pes cavus			
Theoretical movements in the sagittal plane		Force pathway			
					
Respondent patterns in support					
PC 3 1/2 					

APPENDIX 21.18 Functions suggested by patterns with pes cavus

Function and description		Previously suggested by			
Foot placed down and lifted vertically with dragging of toes at toe-off due to retraction <i>Foot placed and lifted vertically with careful ground contact, but dragging of tip at vertical lift</i>		Neale (p37)			
Theoretical movements in the sagittal plane		Force pathway			
					
Respondent patterns in support					
PC 47/2 					


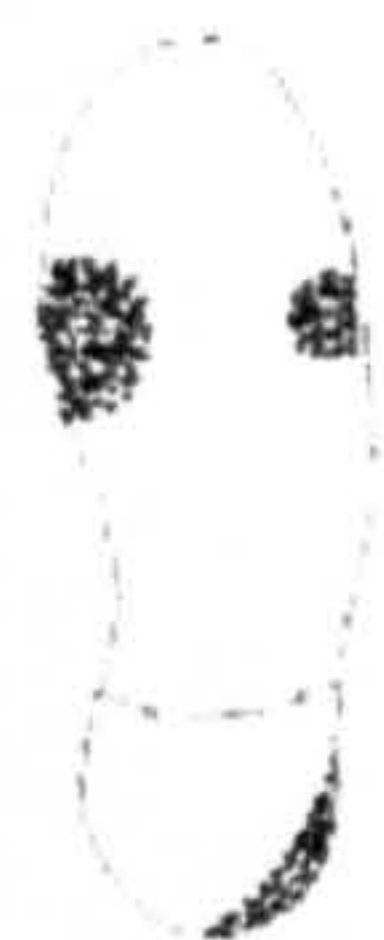



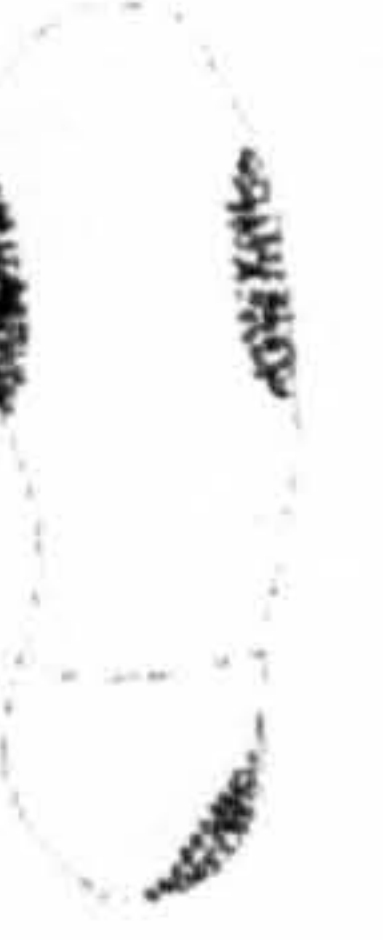




APPENDIX 22.1 Functions suggested by patterns with rearfoot varus

Function and description		Previously suggested by			
<u>Foot inverted on heel strike, remaining inverted throughout stance</u> <i>Foot lands in inversion due to rearfoot varus, remaining inverted in the forefoot with the force pathway remaining lateral.</i>		Root, Orien and Weed (p436-437) Neale (p47)			
Theoretical movements in the sagittal plane		Force pathway			
Not applicable					
Respondent patterns in support					
RFV 24/2	RFV 23/2	RFV 8/1	RFV 26/2	RFV 22/1	RFV 52/4
					
RFV 42/1	RFV 37/2	RFV 52/1	RFV 54/2	RFV 1/3	RFV 15/1
					

APPENDIX 22.1 – contd.

Respondent patterns in support (contd.)					
RFV 21/1	RFV 18/1	RFV 35/2	RFV 5/4	RFV 53/4	RFV 55/3
RFV 53/2	RFV 16/2	RFV 13/1	RFV 48/1	RFV 52/3	RFV 2/2
RFV 20/3	RFV 28/2	RFV 12/2	RFV 33/2	RFV 29/2	RFV 39/1




APPENDIX 22.2 Functions suggested by patterns with rearfoot varus

Function and description		Previously suggested by			
<u>Foot inverted on heel strike, reverting to normal inclination at forefoot</u> <i>Foot in inversion at heel strike due to rearfoot varus, correcting to normal inclination at forefoot, with the force pathway changing from initial lateral position, to more normal central position</i>		Root, Orien and Weed (p327) Neale p47			
Theoretical movements in the sagittal plane		Force pathway			
Not applicable					
Respondent patterns in support					
RFV 53/3	RFV 26/3	RFV 24/2	RFV 2/3	RFV 34/3	RFV 1/1
					
RFV 44/1	RFV 42/2	RFV 24/1			
					














APPENDIX 22.3 Functions suggested by patterns with rearfoot varus

Function and description		Previously suggested by			
<u>Foot inverted on heel strike, followed by pronation</u> <i>Foot either attempts to compensate for pronation through inversion at heel strike, later succumbing to pronation, or has a rearfoot varus resulting in lateral heel strike, which is over-corrected through excessive pronation. In both cases, initial laterally-inclined force pathway moves medially in the forefoot</i>		Root, Orien and Weed (p298) Neale (p37)			
Theoretical movements in the sagittal plane		Force pathway			
Not applicable					
Respondent patterns in support					
RFV 12/1 	RFV 38/1 	RFV 4/1 	RFV 18/2 	RFV 30/1 	RFV 14/1
RFV 34/4 	RFV 11/2 	RFV 1/2 	RFV 5/2 	RFV 3/1 	RFV 54/1













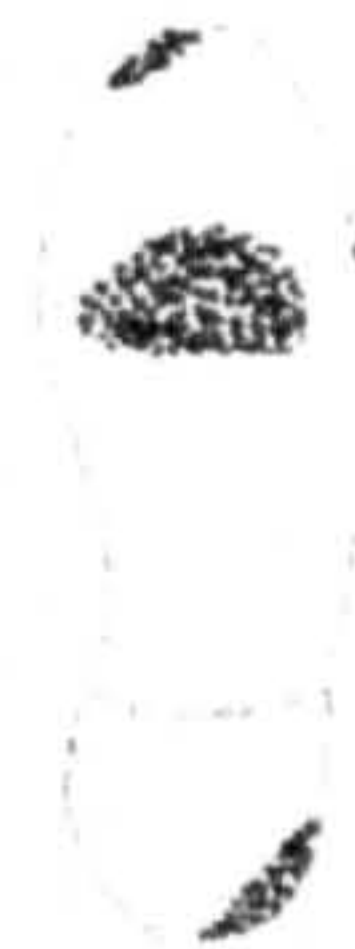







APPENDIX 22.3 – contd.

Respondent patterns in support					
RFV 51/2	RFV 52/2	RFV 50/1			
					















APPENDIX 22.4 Functions suggested by patterns with rearfoot varus

Function and description		Previously suggested by			
<u>Foot inverted throughout with abduction</u> <i>Foot lands in inversion with marked abduction due to rearfoot varus, remaining inverted in the forefoot with the force pathway moving from an initial posterior lateral position, directly across the foot to a medial anterior toe-off position.</i>		Neale (p37)			
Theoretical movements in the sagittal plane		Force pathway			
Not applicable					
Respondent patterns in support					
RFV 35/1	RFV 36/1	RFV 40/1	RFV 8/1	RFV 23/2	RFV 26/2
					
RFV 34/2	RFV 22/1	RFV 52/4	RFV 1/3	RFV 54/2	RFV 52/1
					


APPENDIX 22.4 – contd.

Respondent patterns in support – contd.					
RFV 37/2 	RFV 42/1 	RFV 21/1 	RFV 33/2 	RFV 15/1 	RFV 5/4 
RFV 18/1 	RFV 35/2 	RFV 53/4 	RFV 53/2 	RFV 55/3 	RFV 35/3 
RFV 20/2 	RFV 31/2 	RFV 2/2 	RFV 48/1 	RFV 52/3 	RFV 12/2 
RFV 20/3 	RFV 28/2 				

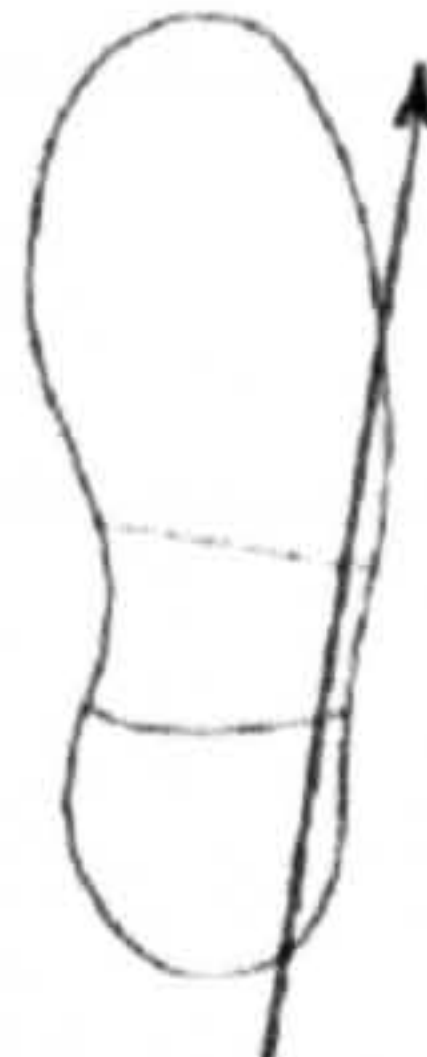












APPENDIX 22.5 Functions suggested by patterns with rearfoot varus

Function and description		Previously suggested by			
<u>Foot inverted throughout stance with abduction and walking on heels</u> <i>Foot lands in inversion with marked abduction due to rearfoot varus, remaining inverted with weight bearing concentrated on the heels and no toe-off. The force pathway moves from an initial posterior lateral position in a medial anterior direction, but lifts prior to toe-off.</i>		Not previously suggested in association with rearfoot varus			
Theoretical movements in the sagittal plane		Force pathway			
					
Respondent patterns in support					
RFV 43/1	RFV 32/1	RFV 37/1	RFV 46/1	RFV 41/1	RFV 45/1
					
RFV 5/1	RFV 26/1	RFV 17/1	RFV 8/2	RFV 19/1	RFV 25/1
					


APPENDIX 22.5 – contd.

Respondent patterns in support – contd.					
RFV 40/2 					












APPENDIX 22.6 Functions suggested by patterns with rearfoot varus

Function and description		Previously suggested by			
<u>Foot inverted throughout with adduction (intoing)</u> <i>Foot lands in inversion and adduction with weight bearing and the force pathway remaining on the extreme lateral aspect of the foot throughout stance</i>		Root, Orien and Weed (p158) Neale (p47)			
Theoretical movements in the sagittal plane		Force pathway			
Not applicable					
Respondent patterns in support					
RFV 8/1	RFV 23/2	RFV 26/2	RFV 34/2	RFV 22/1	RFV 52/4
					
RFV 1/3	RFV 54/2	RFV 52/1	RFV 37/2	RFV 42/1	RFV 33/2
					





APPENDIX 22.6 – contd.

Respondent patterns in support – contd.					
RFV 29/2 					













APPENDIX 22.7 Functions suggested by patterns with rearfoot varus

Function and description				Previously suggested by	
Foot pronated prior to heel strike and throughout stance <i>Foot moves into pronated position prior to heel strike to compensate for rearfoot varus and remains pronated throughout stance with medial force pathway throughout</i>				Not previously suggested in association with rearfoot varus	
Theoretical movements in the sagittal plane				Force pathway	
Not applicable					
Respondent patterns in support					
RFV 11/3	RFV 49/1	RFV 7/2	RFV 18/4	RFV 33/3	RFV 55/1
					
RFV 55/2	RFV 51/1	RFV 2/1	RFV 28/3		
					

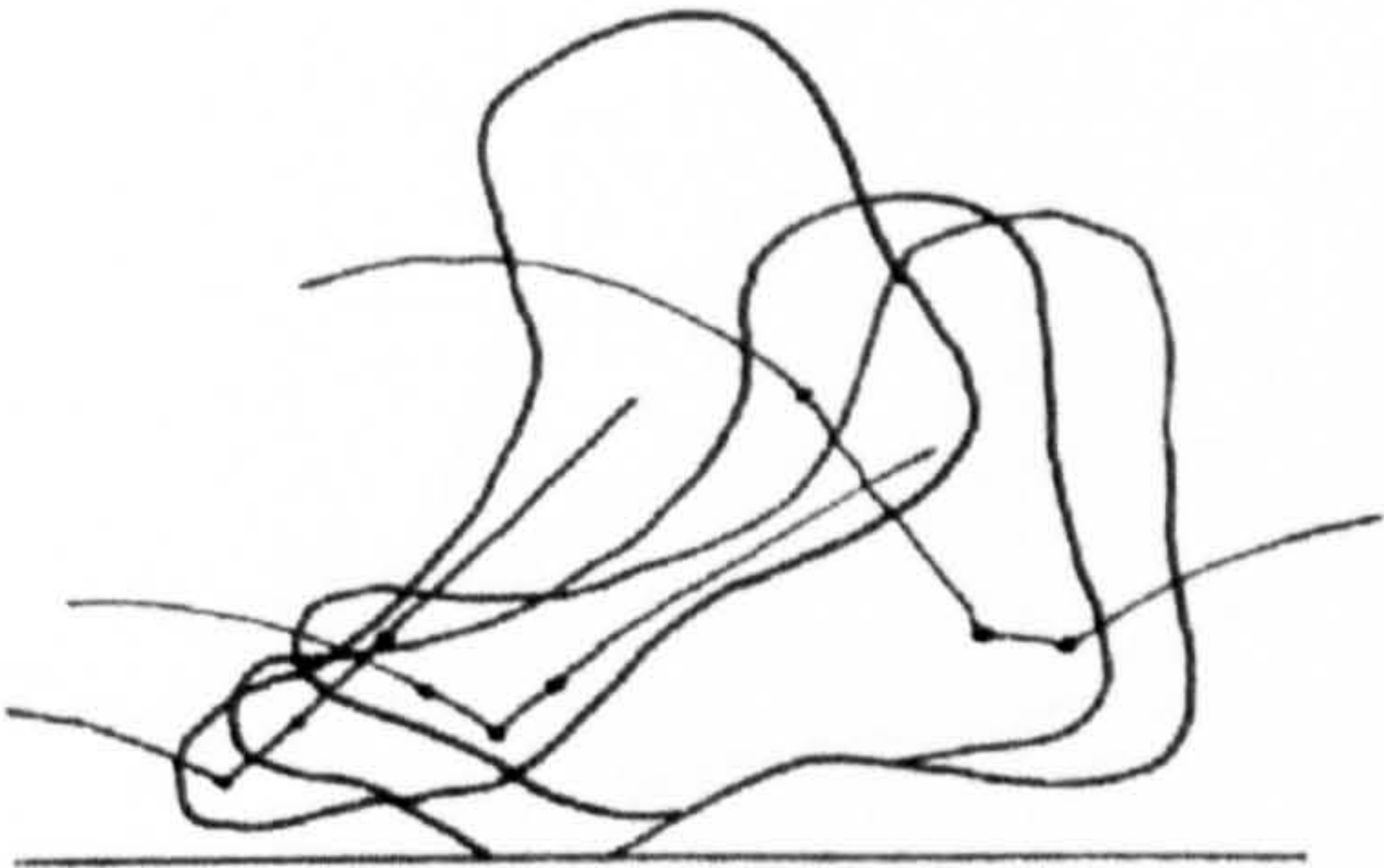


APPENDIX 22.8 Functions suggested by patterns with rearfoot varus

Function and description			Previously suggested by			
<u>Foot lands in pronation then transfers to inversion to compensate</u> <i>Medial strike due to pronated position, with force pathway transferring laterally as foot inverts to compensate</i>			Root, Orien and Weed (p120)			
Theoretical movements in the sagittal plane			Force pathway			
Not applicable						
Respondent patterns in support						
RFV 51/3	RFV 31/3	RFV 29/1				
						





APPENDIX 22.9 Functions suggested by patterns with rearfoot varus

Function and description						Previously suggested by
<p>Foot lands in inversion, then pronates with abductory twist to compensate Foot lands in inversion, with lateral force pathway. Foot then pronates to compensate for inversion with abductory twist resulting in force pathway transferring medially, markedly so when abductory twist occurs</p>						Not previously suggested in association with rearfoot varus
Theoretical movements in the sagittal plane						Force pathway
Not applicable						
Respondent patterns in support						
RFV 23/1	RFV 18/3	RFV 9/1	RFV 18/3	RFV 23/3	RFV 54/3	
						
RFV 53/1	RFV 20/1	RFV 13/2	RFV 5/3	RFV 31/1		
						





APPENDIX 22.10 Functions suggested by patterns with rearfoot varus

Function and description		Previously suggested by			
<u>Inversion with heel equinus leading to no heel strike and pronation</u> <i>Restricted dorsiflexion occurs with the inversion, markedly limiting heel strike. Ground contact occurs mid-foot and accompanying pronation to compensate for heel inversion transfers the force pathway medially</i>		Root, Orien and Weed (p174) Neale (p47)			
Theoretical movements in the sagittal plane		Force pathway			
					
Respondent patterns in support					
RFV 6/1 					

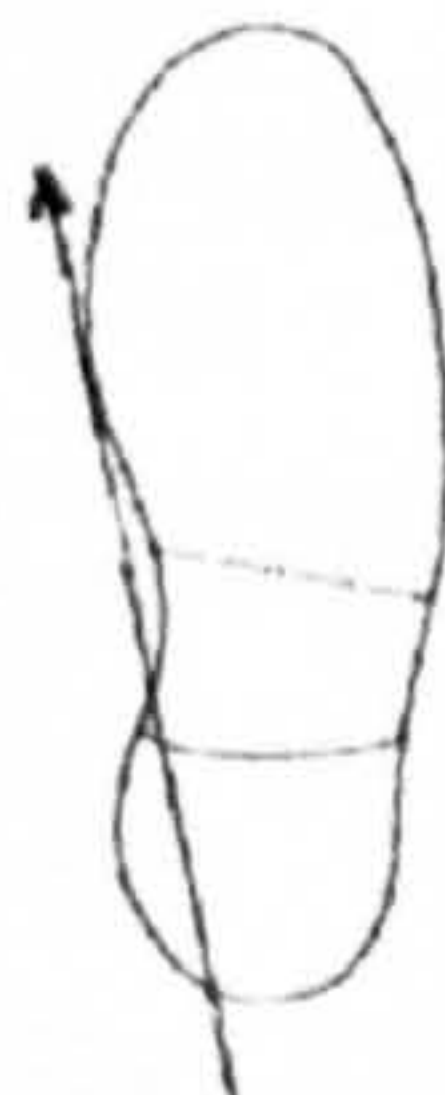




APPENDIX 22.11 Functions suggested by patterns with rearfoot varus

Function and description		Previously suggested by			
<u>Inversion with heel equinus leading to no heel strike and compensation via abductory twist</u> <i>Restricted dorsiflexion occurs with the inversion, markedly limiting heel strike. Ground contact occurs mid-foot and accompanying pronation with abductory twist to compensate for heel inversion transfers the force pathway medially, markedly when abductory twist occurs</i>		Not previously suggested in association with rearfoot varus			
Theoretical movements in the sagittal plane		Force pathway			
					
Respondent patterns in support					
RFV 22/2	RFV 32/2				
					

APPENDIX 22.12 Functions suggested by patterns with rearfoot varus

Function and description			Previously suggested by			
<u>Forefoot supination (or adductory twist)</u> <i>Inversion occurs when mid-stance phase is encountered with force pathway transferring from normal to lateral position. Alternately, adductory twist takes place at mid stance, with same force pathway effect</i>			Not previously suggested in association with rearfoot varus			
Theoretical movements in the sagittal plane			Force pathway			
Not applicable						
Respondent patterns in support						
RFV 39/1	RFV 11/1	RFV 6/2				
						

APPENDIX 22.13 Functions suggested by patterns with rearfoot varus

Function and description				Previously suggested by	
<u>Compensatory eversion with abduction</u> <i>Foot everts to compensate for rearfoot varus resulting in medial strike. Accompanying abduction of the foot results in an extreme medial force pathway avoiding full forefoot weight bearing</i>				Root, Orien and Weed (p297) Neale (p47)	
Theoretical movements in the sagittal plane				Force pathway	
Not applicable					
Respondent patterns in support					
RFV 7/1	RFV 10/1	RFV 33/1	RFV 32/3		
					

APPENDIX 23 Summary of “named variable” analysis

Named variable	No. times named with main conditions					Wear associations	Strength of wear assoc.	Notes
	Total	Pron.	HR	PC	RFV			
Equinus	11	3	1	7	0	Wear across MPJt area	Strong	
						No heel wear	Strong	
Rearfoot valgus	3	3	0	0	0	Ant. med. segment wear	Strong	
						Med. heel wear	Strong	
Forefoot inv./varus	7	2	3	2	0	Med. heel wear	Strong	With Pron. only
						Ant. med. segment wear	Strong	With Pron. only
						5 th MPJt wear	Strong	With HR and PC only
						Ant. med. segment wear	Strong	With HR only
Pl.fl. 1 st ray	14	4	1	3	6	1 st MPJt wear	Strong	With RFV and RFV+HR only
						Post./lat. heel wear	Moderate	
						5 th MPJt wear	Strong	
Abd. Twist	15	8	4	2	1	Localised central met. wear	V. strong	With Pron. only
						Localised 1 st MPJt wear	1 only	
						Post./lat. heel wear	Moderate	
						Ant./med. segment wear	Strong	
Abducted gait	6	1	2	1	2	Post./lat. heel wear	Strong	
						Central met. wear	Strong	
						Ant./med. segment wear	Strong	
Adducted gait	3	1	2	0	0	Ant./med. segment wear	Strong	With HR only
						Central/lat. central wear	Moderate	
O'loaded 2 nd MPJt	2		1	0	1	2 nd /3 rd MPJt wear	Strong	
HAV	2	1	1	0	0	Med. forefoot wear	Strong	
Arthritis	2	1	1	0	0	Post./lat. heel wear	Strong	
						Tip of 1 st wear	Strong	
						Absent met. area wear	Strong	
Calc. Varus/inversion	4	2	0	2	0	Lat. heel wear	Strong	
						5 th MPJt wear	Strong	
						Ant. med. segment wear	Strong	
						Central MPJt. wear	Moderate	
Comp. Pes cavus	3	0	0	3	0	Central MJt wear	Strong	With PC only
Comp. pronation	3	3	0	0	0	Ant. med. segment wear	Moderate	With Pron. only

APPENDIX 23 Summary of “named variable” analysis

Named variable	No. times named with main conditions					Wear associations	Strength of wear assoc.	Notes
Comp. rearfoot varus	21	3	0	0	18	Post/lat. heel wear	Moderate	
						1 st toe area wear	Moderate	
D'flexed 1 st +5 th mets	2	1	0	1	0	Post/lat. heel wear	Strong	
						Central MPJt. wear	Strong	
Fixed/severe pronation	21	19	1	0	1	Med. heel wear	Strong	
						Ant. med. segment wear	Strong	
H. Limitus	2	2	0	0	0	1 st toe area wear	Strong	With Pron. only
H'mob. 1 st ray	3	3	0	0	0	Central MPJt. wear	Strong	With Pron. only
H'mob. Pronation	3	3	0	0	0	Post/lat. heel wear	Strong	With Pron. only
						Ant. med. segment wear	Strong	
IPJt extn.	2	0	2	0	0	1 st toe area wear	Strong	With HR only
Mobile Pes cavus	3	0	0	3	0	Central MPJt. wear	Strong	With PC only
Painful hallux	3	0	3	0	0	Post/lat. heel wear	Strong	With HR only
						5th MPJt. wear	Strong	
						Central MPJt. wear	Strong	
						1 st toe area wear	Strong	
Part. comp. pronation	3	3	0	0	0	Post/lat. heel wear	Strong	With Pron. only
						5th MPJt. wear	Strong	
						1st MPJt. wear	Strong	
Part. comp. rearfoot varus	15	0	0	0	15	Post/lat. heel wear	Strong	With RFV only
						5th MPJt. wear	Strong	
						1 st toe area wear	Strong	
Rigid pes cavus	6	0	0	6	0	1st MPJt. wear	V.Strong	With PC only
						5th MPJt. wear	V.Strong	
						Central heel wear	Moderate	
Rigid pl. fl. 1 st +5 th MPJts	3	0	0	3	0	1st MPJt. wear	V.Strong	With PC only
						5th MPJt. wear	V.Strong	
						Central heel wear	Moderate	

APPENDIX 24 Questionnaire to determine criteria to be used as definitions for the inter-observer reliability trial

Explanatory notes

The questionnaire consists of 4 sections :

- Section 1 definitions/criteria for the visual recognition of pathologies
- Section 2 definitions/criteria for the visual recognition of gait types
- Section 3 definitions/criteria for the visual recognition of described ranges of movement
- Section 4 definitions/criteria for the visual recognition of footwear variables

In each section are given lists of conditions or states which may act as variable factors in the production of shoe wear patterns.

Each named condition or state requires a short definition which would allow you to state how you recognised it, or what factors would need to be present in order to trigger a conclusion that the state or condition was present without the availability of specialised measuring instruments.

The definition given should be a working definition, easily understood by other podiatrists and which, if accepted would allow two podiatrists using that definition to agree as to whether an observed patient was exhibiting that condition or not.

The definition should be based on the considerations that you would have given before writing a diagnosis or observed state on a clinical record card.

If you believe that some of the condition or states included in the questionnaire would be unlikely to influence shoe wear patterns, please mark these with a cross.

If you cannot answer any of the questions, please leave those sections blank, though an attempt to answer all of the questions is preferable.

When completing the questionnaire, you may be in the same room as other participants. It is important that your response is kept anonymous from the other participants and that you don't openly discuss your responses with the others at any stage of the procedure.

There is no time limit allocated to completion of the questionnaire.

You may be asked to participate in subsequent rounds of the questionnaire. In this case, all the responses received in the first round will be summarised and presented to you along with the proportions of participants who had given each response. You would then consider these responses and indicate which you would agree with. In any subsequent rounds, you may change your response from that given previously in light of viewing the responses as a whole. You may also agree with more than one response if you wish.

APPENDIX 24 -contd.

Questionnaire section 1

<p>Thank you for agreeing to participate in this phase of my research project. <u>You are asked to consider the three sections presented in this questionnaire and provide a simple definition or simple criteria for the visual recognition of each given condition or state. If there are any conditions which you feel would be irrelevant to a project investigating shoe wear patterns, please mark these with a cross (X).</u> Two examples for hallux rigidus and hallux valgus are already given in section one. When you have completed all three sections, please hand the questionnaire in. Thank you.</p>	
<p>Section 1 Definitions/criteria for the visual recognition of pathologies</p>	
Name of condition	My definition of this condition is :
ABDUCTION	
ABDUCTION AND EVERSION	
ADDUCTION	
ADDUCTION AND EVERSION	
ANKLE EQUINUS	
BOW LEGS	
CALCANEAL APOPHYSITIS	
CALCANEAL BURSITIS	
CALCANEAL EVERSION	
CALCANEAL SPUR	
CALCANEAL VALGUS	
CALCANEAL VARUS	
CALCANEAL VALGUS (COMPENSATED)	
CHARCOT JOINTS	

APPENDIX 24 - contd.

Name of condition	My definition of this condition is :
CHOREA	
CLAW TOES	
DIGITI QUINTI VARUS	
DROP FOOT	
EQUINO-CAVUS	
EQUINO-VARUS	
EVERTED FOOT	
EXCESSIVE ANKLE DORSIFLEXION	
FOOT STRAIN	
FOREFOOT VALGUS	
FOREFOOT VARUS	
FREIBERG'S INFRACTION	
GENU VALGUM	
GENU VARUM	
HALLUX FLEXUS	
HALLUX RIGIDUS	Fused 1st MJt and $< 15^{\circ}$ lat. deviation
HALLUX VALGUS	$> 15^{\circ}$ lat. deviation
HAMMERED 2ND TOE	
HEMIPLEGIC GAIT	
HINDFOOT VALGUS	
HINDFOOT VARUS	
HYPERMOBILE 1ST AND 5TH MPJts	
HYPERMOBILE FOOT	
INFLARED FOOT	

APPENDIX 24 - contd.

Name of condition	My definition of this condition is :
INVERTED FOOT	
KOHLERS DISEASE	
LOWER MOTOR NEURONE WEAKNESS	
METATARSUS ADDUCTUS	
METATARSUS PRIMUS ELEVATUS	
METATARSUS PRIMUS VARUS	
OUT-TOED GAIT	
OVERLOADED 2ND MET.	
PAINFUL NAIL DISORDERS OF THE 1ST TOE	
PARAPARESIS	
PES CAVUS	
PES PLANO-VALGUS	
PLANTAR DIGITAL NEURITIS (MORTON'S TOE)	
PLANTAR FASCIITIS	
PLANTAR FLEXED 1ST AND 5TH TOES	
PLANTAR FLEXED TOES	
POST-OPERATIVE STATES	
PRONATED FOOT	

APPENDIX 24 - contd.

Name of condition	My definition of this condition is :
PYRAMIDAL NEUROLOGICAL DISORDERS	
REDUCTION OF LONGITUDINAL AND TRANSVERSE ARCHES	
RETRACTED TOES	
RETRO-CALCANEAL BURSITIS	
SEVERS DISEASE	
SHORT 1ST METATARSAL	
SHORT 5TH METATARSAL	
SPLAYING OF THE METATARSALS	
TAYLORS BUNION	
TALIPES CALCANEAL VALGUS	
TALIPES CALCANEAL VARUS	
TALIPES EQUINO VALGUS	
TALIPES EQUINO VARUS	
TARSAL ARTHRITIS	
VERTICAL TALUS	
If you feel that any other conditions should have been given in the list above, please name these below and provide a short definition of each one.	
Name of condition	My definition of this condition is :

APPENDIX 24 - contd.

Questionnaire section 2

Section 2 Criteria for the visual recognition of gait types	
Gait type	My criteria for the recognition of this gait is :
ABDUCTED GAIT	
GAIT WITH ABDUCTORY TWIST	
GAIT WITH ADDUCTORY TWIST	
ADDUCTED GAIT	
ATAXIC GAIT	
BOW LEGGED GAIT	
CALCANEAL GAIT	
GAIT WITH CLASSIC HALLUX RIGIDUS FOOT FUNCTIONING	
DROP FOOT GAIT	
HEMIPLEGIC GAIT	
HIGH STEPPING GAIT	
NORMAL GAIT	
INTOED GAIT	
OUT-TOED GAIT	
PARAPLEGIC GAIT	
PRONATING GAIT	
SHUFFLING GAIT IN PARKINSONISM	
SUPINATING GAIT	
WADDLING GAIT	
If you feel that any other gait types should have been given in the list above, please name these below and provide a short definition of each one.	
Gait type	My criteria for recognising this gait type is :

APPENDIX 24 - contd.

Questionnaire Section 3

Section 3 Criteria/definitions for the visual recognition of described ranges of movement	
Described range of movement	My definition of this described range of movement is :
Restricted ankle movement	
Normal ankle movement	
Excessive ankle movement	
Excessive forefoot inversion	
Normal forefoot movement	
Excessive forefoot eversion	
Excessive rearfoot inversion	
Normal rearfoot movement	
Excessive rearfoot eversion	
Restricted toe movement	
Normal toe movement	
Excessive toe movement	
Restricted overall foot mobility	
Normal overall foot mobility	
Hypermobile foot	
If you feel that any other described ranges of movement should have been given in the list above, please name these below and provide a short definition of each one.	
Described range of movement	My definition of this described range of movement is :

APPENDIX 24 - contd.

Questionnaire section 4

Section 4 Criteria/definitions for the visual recognition of footwear variables	
Described footwear variable	My definition of this described variable is :
Low heel height	
Medium heel height	
High heel height	
Thin sole	
Medium sole	
Thick sole	
New shoe condition	
Used shoe condition	
Poor shoe condition	
Shallow toe box	
Normal depth toe box	
Deep toe box	
Sole unworn	
Light wear on sole	
Average wear on sole	
Heavy wear on sole	
Shoe length short	
Shoe length acceptable	
Shoe length excessive	
Shoe width tight	
Shoe width acceptable	
Shoe width excessive	
Overall shoe depth shallow	

APPENDIX 24 - contd.

Described footwear variable	My definition of this described variable is :
Overall shoe depth acceptable	
Overall shoe depth excessive	
Heel fit of shoe tight	
Heel fit of shoe acceptable	
Heel fit of shoe loose	
Toe box too tight	
Toe box of shoe acceptable	
Toe box of shoe too broad	
If you feel that any other footwear variables should have been given in the list above, please name these below and provide a short definition of each one.	
Described footwear variable	My definition of this described variable is :
Thank you for completing this questionnaire. Please hand this in when completed.	
Wesley Vernon SWaMP Project Research Student Sheffield Hallam University	

APPENDIX 25 Comparison of agreements achieved in round 6 with previous opinion

Section 1 Definitions/criteria produced for the visual recognition of pathologies		
Condition	Round 1 definitions given	Compatible with previous opinion (✓/✗)
Abduction	A motion away outward from the mid-line of the body in the transverse plane.	✓ (1)
Abduction and eversion	A motion away outward from the mid-line of the body in the transverse plane, eversion is a motion outward from the mid-line in the frontal plane	✓ (1)(3)
Adduction	Foot diverted towards the midline of the body in the transverse plane	✓ (1)
	A motion inward from the mid-line of the body in the transverse plane	✓ (1)
Adduction and eversion	A motion inward from the mid-line of the body in the transverse plane. Add is an inward motion in the trans. Eversion outward motion in the frontal plane	✓ (1)(3)
Ankle equinus	Restriction of ankle joint dorsiflexion less than 10° dorsiflexion=Ankle Equinus	✓ (2)(3)
Bow legs	Outward curvature of the legs whereby the gap between the knees is greatest	✓ (1)
Calcaneal apophysitis	Where the insertion of ligament/tendon is partly pulled away from the bone-usually gives point tenderness - Stone Bruise-will show as a hot spot on CT scan.	✓ (2)
Calcaneal bursitis	Inflamed bursa, painful on direct pressure directly under calc	✓ (2)
Calcaneal eversion	Where the calc everts i.e. moves away from the midline in frontal plane	✓ (2)
Calcaneal spur	Bony exostosis on calc-step usually horizontal-shows on X ray	✓ (2)
	Bony prominence on the calc resembling a coat hook at the insertion of the tendon	✓ (2)
Calcaneo-valgus	Everted calc – weightbearing	✓ (2)(3)
Calcaneo-varus	Inverted calc - weightbearing	✓ (2)(3)
Calcaneo-varus (Comp.)	Talus inverted to attain ground contact in above	✗ (2)(3) ^(A)
Charcot joints	Destruction of joints with neurological damage leading to collapse of the structure and flat foot	✓ (1)(2)(3)
Chorea	St Vitus dance - shaking partly uncontrolled movements	✓ (1)(2)
Claw toes	Where proximal IPJs are df and toes plantarflex getting below level of mets	✓ (2)(3)

APPENDIX 25 -contd.

Condition	Round 1 definitions given	Compatible with previous opinion (✓/✗)
Digiti quinti varus	Fifth digit inverted	✓(2)(3)
	Inverted 5 th toe	✓(2)(3)
	Rolling in of the 5 th toes towards the centre line of the foot	✓(2)(3)
Drop foot	Flaccid muscles/poor muscle tone preventing control of dorsi/plantar flexion	✗ (3) ^(B)
Equino-cavus	Plantar flexed foot position-with high arch	✓(2)
Equino-varus	Plantar flexed foot position-with inverted foot/heel position	-----
Everted foot	Markedly pronated foot	-----
Excessive ankle d'flexion	Flat foot with compression of the medial longitudinal arch and rolling out of the foot	-----
	More than 50° ankle movement (towards tibia)	-----
Footstrain	Being able to move the ankle in a dorsal direction to a point more than a third of the way between the ground and the leg	-----
	Generalised term for foot ache soft tissue in nature	✗ (2) ^(C)
Forefoot valgus	5th MPJt elevated from ground-MPJts not at same level	✓(2)(3)
Forefoot varus	1st MPJt elevated	✓(2)(3)
Freiberg's infraction	Stress fracture of the metatarsal (second)	✗ (2) ^(D)
Genu valgum	Knees together, ankles more than 2cm apart	✓(1)
Genu varum	Knees apart more than 2cm with ankles together	✓(1)
Hallux flexus	Hyperextended 1 st – elevated from ground	?(1)(2) ^(E)
Hallux rigidus	Fused 1st MPJt and < 15° Lat. Deviation	✓(1)(2)(3)
Hallux valgus	> 15° Lat. Deviation	✓(1)(2)(3)
Hammered 2 nd toe	= Plantarflexed metatarsal with df of the proximal phalanx of the 2 nd toe	✓(2)?(1) ^(F) (3) ^(G)
Hemiplegic gait	A gait. One side is affected by paralysis i.e. from stroke-gives asymmetrical gait	✓(1)?(2) ^(H)
Hindfoot valgus	Everted rear of foot	✓(2)(3)
	The rearfoot is in a position where it is rolling away from the body line	✓(2)(3)
Hindfoot varus	Inverted rear of foot	✓(2)(3)
	The rearfoot is in a position where it is rolling into the body line	✓(2)(3)
Hypermobile 1st and 5th MPJts	Excessive movement of 1st and 5th MPJts-can move independently of other MPJts	✓(3)
Hypermobile foot	Where motion is in excess to normal ranges	?(3) ^(I)
	All joints of the foot move beyond the required range of motion	?(3) ^(J)
Inverted foot	Plantar of foot facing towards the midline of the body	✓(1)

APPENDIX 25 -contd.

Condition	Round 1 definitions given	Compatible with previous opinion (✓/✗)
Kohlers disease	Navicular-pathology with ossification?	✓(1)(2)
Lower motor neurone weakness	Poor muscle control and strength with loss of tone/bulk	✓(1)(3)
Metatarsus adductus	Met facing towards the midline of body	✓(1)(2)
Metatarsus primus elevatus	Raising of the first met in a non-weightbearing position	✓(2)(3)
Metatarsus primus varus	Rolling in of the first met in a non-weightbearing position	✓(2)(3)
Out-toed gait	Walking with the toes pointing to a 10 to 2 position or greater	✓(2)(3)
	Gait where the toes are pointing away from the centre of the body	✓(2)(3)
Overloaded 2nd met.	Plantar 2nd MPJt-HD or callosity	✓(2)(3)
	Excessive weightbearing over the head of the 2nd met	✓(2)(3)
Painful nail disorders of the 1st toe	Conditions whereby the patient suffers discomfort as a result of damage or related conditions affecting the nail	✓(2)
Paraparesis	No sensation or control of movement	✗ (1) ^(K)
Pes cavus	High arched foot	✓(1)(2)
Pes plano-valgus	Flat foot	✓(1)(2)
Plantar digital neuritis (Morton's toe)	Pain between 3-4 mets. Compress ff and palpate if painful click = Morton's	✓(1)(2)
	Pain at the 3 rd and 4 th MPJ. On movement a clicking sound may be audible	✓(1)(2)
Plantar fasciitis	Plantar aspect painful to weightbear-may be tight and inflamed	✓(1)(2)
	Inflammation of the P.F. and its perifascial tissues	✓(1)(2)
	Inflammation of the plantar fascia causing discomfort on weightbearing on the plantar area	✓(1)(2)
	Inflammation of fascia in the foot	✓(1)(2)
Plantar flexed 1 st and 5 th toes	Where these sit below the level of the other metatarsals (NB replies refer to mets. and not toes)	✓(2)
Plantar flexed toes	All toes are in a position where they are in a lower plane than the norm when non-weightbearing	-----
Post-operative states	Following surgery with evidence of inflammation/trauma	✓(1)
Pronated foot	A foot comprising eversion, abduction and plantarflexion leading to flat foot and flattened arch on weightbearing	✓(1)(2)(3)
Pyramidal neurological disorders	No fine movement control	?(2) ^(L)

APPENDIX 25 -contd.

Condition	Round 1 definitions given	Compatible with previous opinion (✓/✗)
Reduction of longitudinal and transverse arches	Flattened arches	-----
	Flattening of the arches of the foot on weightbearing	-----
Retracted toes	Extensor tendons pulling toes into clawed position	?(1) ^(M)
	Toes curling upwards into a non-weightbearing position	✓(2)
Retro-calcaneal bursitis	Post calc inflamed bursa over Haglands bump	✓(1)(2)(3)
	Soft tissue swelling that displaces on the back of the heel at the insertion of A.T.	✓(1)(2)(3)
Short 1st metatarsal	Reduced length of the 1st met	✓(2)(3)
Short 5th metatarsal	5th appears shorter than other digits, but phalanx normal	-----
Splaying of the metatarsals	Gradual widening of the gap between the metatarsals from the base to apex beyond the norm leading to an excessively broad forefoot	✓(2)(3)
Tailors bunion	Lateral deviation and subluxation and bony exostosis of the 5th met head	✓(2)?(3) ^(N)
Talipes calcaneo valgus	-Congenital deformity. Where calc slips back off talus	✓(1)(2)
Talipes calcaneo varus	- congenital. Where heel is inverted. Tilt inward on the frontal plane	✓(2)
Talipes equine varus	Ankle fixed in inverted position	✗ (1) ^(O) (2) ^(P)
Tarsal arthritis	Pain and stiffness ankle-crepitus palpated	✓(2)
	Destruction of the joints of the midfoot leading to loss of range of motion and bony prominences	✓(2)
Vertical talus	Talus in straight position	✗ (2) ^(Q)

APPENDIX 25 -contd.

Section 2 Criteria for the visual recognition of Gait types		
Gait type	Round 1 definitions given	Compatible with previous opinion (✓/✗)
Abducted gait	Walking with feet positioned pointing away from midline of body	✓(2)(3)
Gait with abductory twist	When heel lifts heel flicks inward from the back in the transverse plane	-----
Gait with adductory twist	When the heel lifts heel flicks outward from the back in the transverse plane	-----
Adducted gait	Walking with feet positioned pointing towards midline	✓(2)(3)
	The feet point towards one another, or in that direction, on walking	✓(2)(3)
	Gait where foot is facing towards the midline of the body	✓(2)(3)
Ataxic gait	Unsteady, jerky gait style	✓(1)(2)
Bow legged gait	Walking with the knees being the furthest point apart and the feet loading laterally	-----
Calcaneal gait	Walking with great emphasis on the heel. Walk on the heel	✓(2)
Gait with classic hallux rigidus foot functioning	Toe off from medial border of foot	✗ (2) ^(R) (3) ^(S)
Drop foot gait	Forefoot slaps to floor after heel contact – no control	✓(2)(3)
	Forefoot strike with rock back on to heel	✓(2)(3)
Hemiplegic gait	Half of body circumducting during swing phase	✓(2)
High stepping gait	Excessive clearing of foot from ground during swing phase	?(2) ^(T) (3) ^(U)
	Gait with very high steps	?(2) ^(T) (3) ^(U)
Normal gait	Slightly inverted on heel strike, moving to neutral on lift off and rolling off forefoot centrally	✓(2)(3)
Intoed gait	Toes pointing towards midline of body throughout cycle	✓(1)(2)(3)
	Walking with the toes pointing closer to the body line than directly ahead	✓(1)(2)(3)
	Walking with the toe pointing inwards	✓(1)(2)(3)
Out-toed gait	Toes pointing away from midline of body through cycle	✓(2)(3)
	Walking with the toes pointing away from the body line 10 to 2 or more	✓(2) ✗ (3) ^(V)
	Walking with the toe pointing outwards	✓(2)(3)
P'plegic gait	Poor ground clearance abducted gait with dragging of the feet	✓(2)
Pronating gait	Abduction of the foot, rolling in and flattening of the arches and inefficient propulsion	✓(1)(2)(3)
Shuffling gait in Parkinsons	Dragging of the feet with no ground clearance	✓(2)
	Gait where subject does not lift foot off the ground. Shuffles	✓(2)

APPENDIX 25 -contd.

Gait type	Round 1 definitions given	Compatible with previous opinion (✓/✗)
S'pinating gait	Inverted foot dorsiflexed throughout gait	✓ (3)
Waddling gait	Side to side lateral motion	✓ (1)(2)
Circumducted gait	During swing phase leg laterally moves in a circular motion to clear ground	✓ (1)(2)
Uncomp. equinus	No heel strike	✓ (2)
Partially comp. equinus	Heel lift early	✓ (2)(3)

Section 3 Criteria/definitions for the visual recognition of described ranges of movement		
Range of movement	Round 1 definitions given	Compatible with previous opinion (✓/✗)
Restricted ankle movement	Less than 10 ⁰ of dorsiflexion	✓ (3)
Normal ankle movement	More than 10 ⁰ of dorsiflexion	✓ (3)
Excessive ankle movement	XS of df 30 ⁰	-----
Excessive forefoot inversion	Walking on lateral border/sole wear on lateral border	✗ (3) ^(w)
Normal forefoot movement	15 ⁰ -20 ⁰ roughly	✗ (3) ^(x)
Excessive forefoot eversion	In XS of 15 ⁰ -20 ⁰	✓ (3) ^(y)
Excessive rearfoot inversion	Sole wear lat heel border excessive and call.	✓ (2)(3)
Normal rearfoot movement	Wear post-lat border heel-calc	-----
Excessive rearfoot eversion	Medial calc call. sole wear in conjunction with movement away from body line of more than 1/3 of travel to 90 ⁰	✓ (2)?(3) ^(z)

APPENDIX 25 -contd.

Range of movement	Round 1 definitions given	Compatible with previous opinion (✓/✗)
Restricted toe movement	1 st MTPJ = <65 ⁰ df <20 ⁰ pf 2-5 MTPJ = <30 ⁰ df <15 ⁰ pf	✗ (3) ^(AA)
Normal toe movement	1 st MTPJ = <65 ⁰ df <20 ⁰ pf 2-5 MTPJ = <30-70 ⁰ df <15-20 ⁰ pf	✗ (3) ^(BB)
Excessive toe movement	More than 90 ⁰ dorsal and 30 ⁰ plantar movement	✗ (3) ^(CC)
Restricted overall foot mobility	Being able to move the joints of the foot less than the required range of motion for normal gait	-----
Normal overall foot mobility	Meeting the required range of motion for normal gait	✓ (3)
Hypermobile foot	Majority of motions being in excess of normal values	✗ (3) ^(DD)

Section 4 Criteria/definitions for the visual recognition of footwear variables		
Footwear variable	Round 1 definitions given	Compatible with previous opinion (✓/✗)
Low heel height	2cm or less	-----
Medium heel height	4cm	-----
High heel height	Over 4cm	-----
Thin sole	less than 5mm	-----
Medium sole	1-2cm	-----
Thick sole	2+ cm	-----
New shoe condition	No creases, even uppers, even tread	-----
Used shoe condition	Creased uppers, worn tread	-----
	-worn upper, indentations inside shoe, wear marks on sole	-----
	Some wearing of sole pattern and scuffing of upper. Heel worn.	-----
Poor shoe condition	Sole worn with holes, overhanging uppers	-----
	Extensive wearing of sole and distortion of the shoe body	-----
Shallow toe box	Able to see toe imprints on uppers - shallower on digits	-----
	Too little room in toe box resulting in dorsal compression of toes	-----
Normal depth toe box	Creased, no indentations from digits	-----
Deep toe box	Deeper than digits	-----

APPENDIX 25 -contd.

Footwear variable	Round 1 definitions given	Compatible with previous opinion (✓/✗)
Sole unworn	No markings. If leather, no colour change	-----
	No diminution of sole pattern or wearing of heel	-----
	Sole with clear tread mark	-----
Light wear on sole	Part of tread abraded	-----
	Some diminution of sole pattern but still visible	-----
	Tread mark clear with slight scuffing	-----
Average wear on sole	Distinct lessening of sole pattern in obvious areas and some heel wear	-----
Heavy wear on sole	No tread-possible holes-(or nearly!)	-----
	-marked breakdowns of leather worn through - marked worn rubber - distinct areas of wear	-----
	Extensive lessening/absence of sole pattern to point of affecting function	-----
Shoe length short	Length of shoe too little to accommodate foot ° impingement on apices of toes	-----
Shoe length acceptable	Digits palpated within 1cm of end of shoes	-----
Shoe length excessive	Digits palpated 2cm or more from end of shoe	-----
	More than 1/2" of room such that the foot can move excessively within the shoe	-----
Shoe width tight	Marked indentations from foot structures	-----
Shoe width acceptable	Creases but not indentations on uppers	-----
Shoe width excessive	Uppers baggy or overhanging	-----
Overall shoe depth shallow	-bulging upper - indentations. - loose lace markings - narrow gap	-----
Overall shoe depth acceptable	Contact on the dorsum of midfoot but not with excessive pressure and 1/2" room around forefoot	-----
Overall shoe depth excessive	Excessive room around dorsum of foot and leading to the foot moving excessively in the shoe	-----
Heel fit of shoe tight	Broken upper at heel - top worn. Stains (blood) on upper	-----
Heel fit of shoe acceptable	Doesn't slip or rub. Room for movement	-----
Heel fit of shoe loose	Too much room around heel allowing the heel to move within the heel cup	-----
Toe box tootight	Too little room leading to compression of the toes laterally and dorsally	-----
Toe box of shoe acceptable	1/2" of room around the toes laterally and dorsally	-----

APPENDIX 25 -contd.

Footwear variable	Round 1 definitions given	Compatible with previous opinion (✓/✗)
Toe box of shoe too broad	More then 1/2" of room allowing the foot to move excessively within the shoe	-----

Key

(1) Osol A., Ed. Blakiston’s Pocket Medical Dictionary 3rd Edition, (New York: McGraw-Hill Book Co.), 1973.

(2) Neale D., Common foot disorders: diagnosis and management, (Churchill Livingstone: Edinburgh, London, Melbourne, New York), 1981.

(3) Root M.L., Orien W.P., Weed J.H., Normal and abnormal function of the foot, (Clinical Biomechanics Corporation: Los Angeles, California), 1977.

✗ No conflict with previous published views expressed in texts given.

? Insufficient information provided to compare with previous views.

✓ Conflict with previous published views expressed in texts given.

----- No previous opinion expressed.

Blue text = Consensus in excess of 70% achieved.

Notes on conflicts/ potential conflicts

^(A)Conflict with both Neale (1981) and Root Orien and Weed (1977) who suggest that compensation in Calc. Varus is achieved by pronation at the subtalar joint and not inversion of the talus.

^(B) Conflict in suggesting that there is poor control of plantarflexion. No conflict with regard to poor control of dorsiflexion.

^(C) Conflict with acute foot strain but not with chronic foot strain.

^(D) Conflict in that Neale (1981) states that this is a fracture of the 2nd metatarsal head specifically.

^(E) Possible conflict in that the brevity of the wording used by participants could also to be interpreted to mean the opposite of Hallux Flexus in that the parts of anatomy described to be hyperextended and elevated need to be specified more accurately.

^(F) Possible conflict in that Blakiston’s (Osol, 1973) specifically mentions flexion of both distal phalanges in conjunction with the extended (dorsiflexed) toe.

^(G)Possible conflict in that Root, Orien and Weed (1977) specifically mention flexion of the distal phalanges in conjunction with the extended (dorsiflexed) toe. They also mention the plantar flexion of the metatarsal as a possible cause.

^(H)Although there is no conflict with Neale (1981), in describing an asymmetrical gait, he also specifies that this is with an arc-like dragging movement, with the foot plantarflexed and inverted and the heel being the secondary weightbearing area without primary heel strike. It may therefore be that these are the important factors of recognition, with the definition given not being specific enough.

^(I)Possible conflict in that the brevity of the wording used by participants does not specify movement contrary to the normal plane of joint motion as suggested by Root, Orien and Weed (1977).

^(J) Possible conflict in that the brevity of the wording used by participants does not specify movement contrary to the normal plane of joint motion as suggested by Root, Orien and Weed (1977).

^(K)Conflict with Medical dictionary which suggests that the affectation is partial only.

^(L)There are several other symptoms of recognition given by Neale (1981), so while this definition given can be seen as one of those signs, it may not go far enough to facilitate recognition.

^(M)This definition does not allow differentiation from claw toes.

^(N)Neale (1981) and Root et al suggest that the inclusion of a bursa in addition to these symptoms is

APPENDIX 25 -contd.

necessary for the classification of Tailor's Bunion.

^(O)Blackiston's suggests that this must also include plantarflexion.

^(P)Neale (1981) suggests that this must also include plantarflexion.

^(Q) Neale (1981) suggests that the talus tilts downward and medially in relation to the calc., with the head acting as a wedge between the calc. And the forefoot, the plantar surface having a convex "rocker bottom" appearance.

^(R)Conflict with Neale (1981) who suggests that the lateral border of the foot is overloaded through supination.

^(S)Conflict with Root, Orien and Weed (1977) who suggest that hyperextension of the distal phalanx of the 1st toe is the means of compensation during walking for the 1st stiffening of Hallux Rigidus and that at the Limitus stage, avoidance of the propulsive phase of gait through picking the foot up flatly rather than raising the heel is the typical method.

^(T)While this does not conflict with Neale (1981), he suggests that this is essentially associated with drop foot and this is not mentioned.

^(U) While this does not conflict with Root, Orien and Weed (1977), they suggest that this is essentially associated with drop foot and this is not mentioned.

^(V) Root, Orien and Weed (1977) suggest that normal is up to 15° at heel strike which would make abnormal anything over this and therefore above the 5 to 1 position and not the 10 to 2 position.

^(W)Neale (1981) suggests that this does not usually occur in locomotion, where the 1st met. Segment is required for propulsion and therefore the abnormal inversion/supination is compensated for by pronation of the hindfoot, bringing the medial border of the foot into ground contact.

^(X) Root, Orien and Weed (1977) suggest that there is 20° of inversion and 10° of eversion available in the normal foot (i.e. a 30° range of movement in the frontal plane). As their measurements are taken at the calc., this implies that there would be at least this much movement available in the forefoot and not the 15° to 20° as agreed here).

^(Y)Although Root, Orien and Weed (1977) don't give a range for forefoot movement, their range of movements suggested at the calc. Would appear to approximately conform with this agreement when the additional movement possible at the forefoot is taken into account.

^(Z)While the statement can be seen as conforming with Neale (1981) and Root, Orien and Weed (1977), the wording used is ambiguous and could be subject to a number of different interpretations.

^(AA)Conflict with Root, Orien and Weed (1977) who suggest that lesser toes as well as the Hallux should dorsiflex normally 65°, similar to the 1st MPJt.

^(BB) Conflict with Root, Orien and Weed (1977) who suggest that lesser toes as well as the Hallux should dorsiflex normally 65°, similar to the 1st MPJt.

^(CC) Conflict with Root, Orien and Weed (1977) who suggest that lesser toes as well as the Hallux should dorsiflex normally 65°, similar to the 1st MPJt.

^(DD) Root, Orien and Weed (1977) suggest that hypermobility is only used as a descriptive term when the joints should be providing stability (therefore excessive ranges of motion would only be a factor where this lack of stability is evident).

APPENDIX 26 Forms used for inter observer reliability test

Please work through the following forms, completing each section as you do so.	
Observation number	
Your name	
Date, appointment time and clinic observation made in	
Subject assessment (Left foot)	
Lower limb pathologies present (Please list)	
Foot type/ pathology present (Please list)	
Localised foot pathologies of heel present (Please list)	
Localised foot pathologies of ILA present (Please list)	
Localised foot pathologies of forefoot area present (Please list)	
Localised foot pathologies of hallux present (Please list)	
Localised foot pathologies of lesser toes present (Please list)	
Gait abnormalities present (Please list)	

APPENDIX 26 – contd.

Conditions affecting the whole foot present (Please list)						
Conditions affecting the ankle present (Please list)						
Range of ankle movement (Please tick)	Restricted	<input type="checkbox"/>	Normal	<input type="checkbox"/>	Excessive	<input type="checkbox"/>
Range of forefoot inversion (Please tick)	Restricted	<input type="checkbox"/>	Normal	<input type="checkbox"/>	Excessive	<input type="checkbox"/>
Range of forefoot eversion (Please tick)	Restricted	<input type="checkbox"/>	Normal	<input type="checkbox"/>	Excessive	<input type="checkbox"/>
Forefoot position (Please tick)	Inverted	<input type="checkbox"/>	Normal	<input type="checkbox"/>	Everted	<input type="checkbox"/>
Movement in 2nd toe (Please tick)	Restricted	<input type="checkbox"/>	Normal	<input type="checkbox"/>	Excessive	<input type="checkbox"/>
Movement in 3rd toe (Please tick)	Restricted	<input type="checkbox"/>	Normal	<input type="checkbox"/>	Excessive	<input type="checkbox"/>
Movement in 4th toe (Please tick)	Restricted	<input type="checkbox"/>	Normal	<input type="checkbox"/>	Excessive	<input type="checkbox"/>
Movement in 5th toe (Please tick)	Restricted	<input type="checkbox"/>	Normal	<input type="checkbox"/>	Excessive	<input type="checkbox"/>
Overall foot mobility (Please tick)	Restricted	<input type="checkbox"/>	Normal	<input type="checkbox"/>	Excessive	<input type="checkbox"/>
Subject assessment (Right foot)						
Lower limb pathologies present (Please list)						
Foot type/ pathology present (Please list)						
Localised foot pathologies of heel present (Please list)						
Localised foot pathologies of ILA present (Please list)						
Localised foot pathologies of forefoot area present (Please list)						

APPENDIX 26 – contd.

Localised foot pathologies of hallux present (Please list)						
Localised foot pathologies of lesser toes present (Please list)						
Gait abnormalities present (Please list)						
Conditions affecting the whole foot present (Please list)						
Conditions affecting the ankle present (Please list)						
Range of ankle movement (Please tick)	Restricted	<input type="checkbox"/>	Normal	<input type="checkbox"/>	Excessive	<input type="checkbox"/>
Range of forefoot inversion (Please tick)	Restricted	<input type="checkbox"/>	Normal	<input type="checkbox"/>	Excessive	<input type="checkbox"/>
Range of forefoot eversion (Please tick)	Restricted	<input type="checkbox"/>	Normal	<input type="checkbox"/>	Excessive	<input type="checkbox"/>
Forefoot position (Please tick)	Inverted	<input type="checkbox"/>	Normal	<input type="checkbox"/>	Everted	<input type="checkbox"/>
Movement in 2nd toe (Please tick)	Restricted	<input type="checkbox"/>	Normal	<input type="checkbox"/>	Excessive	<input type="checkbox"/>
Movement in 3rd toe (Please tick)	Restricted	<input type="checkbox"/>	Normal	<input type="checkbox"/>	Excessive	<input type="checkbox"/>
Movement in 4th toe (Please tick)	Restricted	<input type="checkbox"/>	Normal	<input type="checkbox"/>	Excessive	<input type="checkbox"/>
Movement in 5th toe (Please tick)	Restricted	<input type="checkbox"/>	Normal	<input type="checkbox"/>	Excessive	<input type="checkbox"/>
Overall foot mobility (Please tick)	Restricted	<input type="checkbox"/>	Normal	<input type="checkbox"/>	Excessive	<input type="checkbox"/>
Footwear assessment - (Both shoes)						
Heel height (Please tick)	Low	<input type="checkbox"/>	Medium	<input type="checkbox"/>	High	<input type="checkbox"/>
Sole thickness (Please tick)	Thin	<input type="checkbox"/>	Medium	<input type="checkbox"/>	Thick	<input type="checkbox"/>
Depth of toe box (Please tick)	Shallow	<input type="checkbox"/>	Normal	<input type="checkbox"/>	Deep	<input type="checkbox"/>

APPENDIX 26 – contd.

Left shoe									
Condition of shoe (Please tick)	New		Used		Poor				
Sites of heel/sole wear (Please describe)									
Amount of wear (Please tick)	Unworn		Some wear						
	Usual wear		Heavy wear						
Footwear fit - length (Please tick)	Tight		Acceptable		Over-size				
Footwear fit - width (Please tick)	Tight		Acceptable		Over-size				
Footwear fit - depth (Please tick)	Tight		Acceptable		Over-size				
Footwear fit - heel (Please tick)	Tight		Acceptable		Over-size				
Footwear fit - toe box (Please tick)	Tight		Acceptable		Over-size				
Footwear fit - other mismatches (Please describe)									
Right shoe									
Condition of shoe (Please tick)	New		Used		Poor				
Sites of heel/sole wear (Please describe)									
Amount of wear (Please tick)	Unworn			Some wear					
	Usual wear			Heavy wear					
Footwear fit - length (Please tick)	Tight		Acceptable		Oversize				
Footwear fit - width (Please tick)	Tight		Acceptable		Oversize				
Footwear fit - depth (Please tick)	Tight		Acceptable		Oversize				
Footwear fit - heel (Please tick)	Tight		Acceptable		Oversize				
Footwear fit - toe box (Please tick)	Tight		Acceptable		Oversize				
Footwear fit - other mismatches (Please describe)									

APPENDIX 27.1 Calculation of Cohen’s Kappa to test inter-observer reliability – confusion matrix and method

Number of agreements found in the inter-observer reliability tests

Condition/state	Agreements levels between pairs of Observers					
	1 v 2	1 v 3	1 v 4	2 v 3	2 v 4	3 v 4
Lower limb pathologies	10/13 (37%)	7/12 (58%)	10/15 (66%)	5/12 (42%)	9/15 (60%)	8/18 (44%)
ILA pathologies	1/10 (10%)	5/12 (42%)	6/9 (66%)	2/11 (18%)	1/10 (10%)	6/11 (55%)
Foot type	6/14 (45%)	6/12 (50%)	8/10 (80%)	10/17 (59%)	8/15 (53%)	7/12 (58%)
Heel pathologies	0/13 (0%)	2/10 (20%)	2/11 (18%)	6/11 (55%)	8/10 (80%)	5/9 (56%)
Forefoot pathologies	6/11 (55%)	6/11 (55%)	7/13 (54%)	8/11 (73%)	9/12 (75%)	7/12 (58%)
Hallux pathologies	9/16 (56%)	9/17 (53%)	6/16 (38%)	8/11 (73%)	7/11 (64%)	6/12 (50%)
Lesser toe pathologies	8/13 (62%)	1/12 (8%)	2/2 (100%)	5/5 (100%)	2/2 (100%)	3/3 (100%)
Whole foot pathologies	7/7 (100%)	7/7 (100%)	11/11 (100%)	5/5 (100%)	8/8 (100%)	7/7 (100%)
Ankle pathologies	8/8 (100%)	9/9 (100%)	9/9 (100%)	10/10 (100%)	10/10 (100%)	10/10 (100%)
Gait pathologies	4/13 (31%)	5/5 (100%)	11/11 (100%)	7/7 (100%)	5/5 (100%)	5/5 (100%)
Range of jt movement	31/47 (66%)	38/46 (83%)	32/47 (68%)	32/45 (71%)	38/47 (81%)	33/46 (72%)
Shoe fit	32/50 (64%)	39/49 (80%)	29/49 (59%)	36/49 (73%)	40/55 (73%)	35/50 (70%)
Shoe dimensions	9/16 (56%)	9/16 (56%)	11/16 (69%)	10/16 (63%)	10/18 (56%)	11/17 (65%)
Shoe condition	5/11 (45%)	9/11 (82%)	5/11 (45%)	11/11 (100%)	11/11 (100%)	7/11 (64%)
Amount of shoe wear	6/6 (100%)	5/5 (100%)	5/5 (100%)	3/3 (100%)	4/4 (100%)	6/6 (100%)

To calculate the inter-observer agreements between each pair of observers for each condition/state, the method demonstrated by Robson (1993) was used, i.e.:

1. The confusion matrices are drawn up
2. The proportion of agreement (Po) is calculated as follows:

Po =
$$\frac{\text{No. of agreements}}{\text{No. of agreements} + \text{No. of disagreements}}$$
(Expressed as a percentage as the index of agreement)
3. The proportion of agreement expected by chance (Pc) is calculated:

Pc =
$$(P_{1A} \times P_{2A}) + (P_{1B} \times P_{2B}) + (P_{1C} \times P_{2C}) \text{ etc.}$$
(Where 1 = Observer 1
2 = Observer 2
A = Diagnosis 1
B = Diagnosis 2
C = Diagnosis 3 etc.)
4. Cohen’s Kappa is calculated in order to correct for chance:

K =
$$\frac{Po - Pc}{1 - Pc}$$

APPENDIX 27.2 Calculation of Cohen’s Kappa to test inter-observer reliability – Kappa values with interpretation

The Kappa value is compared to the following scale in order to show how good the levels of agreement are. The interpretation used here is that advocated by Lowe (Lowe, 1993:126) :

Kappa	Interpretation
Below zero	Poor agreement
Zero to .20	Slight agreement
.21 to .40	Fair agreement
.41 to .60	Moderate agreement
.61 to .80	Substantial agreement
.81 plus	Almost perfect agreement

Kappa values obtained with interpretation

Diagnostic area	Observer pairing	Kappa value	Interpretation
Lower limb pathologies	1 v 2	.65	Substantial
	1 v 3	.35	Fair
	1 v 4	.53	Moderate
	2 v 3	.13	Slight
	2 v 4	.42	Moderate
	3 v 4	.28	Fair
Inner longitudinal arch pathologies	1 v 2	-.06	Poor (lower than that expected by chance)
	1 v 3	.19	Slight
	1 v 4	.43	Moderate
	2 v 3	.03	Slight
	2 v 4	-.06	Poor (lower than that expected by chance)
	3 v 4	.25	Fair
Foot type	1 v 2	.11	Slight
	1 v 3	-0.09	Poor (lower than that expected by chance)
	1 v 4	.52	Moderate
	2 v 3	.44	Moderate
	2 v 4	.37	Fair
	3 v 4	.25	Fair
Heel pathology	1 v 2	-.16	Poor (lower than that expected by chance)
	1 v 3	.09	Slight
	1 v 4	.06	Slight
	2 v 3	.15	Slight
	2 v 4	.64	Substantial
	3 v 4	.22	Fair
Forefoot pathology	1 v 2	.25	Fair
	1 v 3	.1	Slight
	1 v 4	.33	Fair
	2 v 3	.21	Fair
	2 v 4	.56	Moderate
	3 v 4	.07	Slight
Hallux pathology	1 v 2	.32	Fair
	1 v 3	.28	Fair
	1 v 4	.11	Slight
	2 v 3	.48	Moderate
	2 v 4	.46	Moderate
	3 v 4	.31	Fair
Lesser toe pathology	1 v 2	.27	Fair
	1 v 3	.06	Slight
	1 v 4	1.0	Perfect
	2 v 3	1.0	Perfect
	2 v 4	1.0	Perfect
	3 v 4	1.0	Perfect

APPENDIX 27.2 - contd.

Diagnostic area	Observer pairing	Kappa value	Interpretation
Whole foot pathology	1 v 2	1.0	Perfect
	1 v 3	1.0	Perfect
	1 v 4	1.0	Perfect
	2 v 3	1.0	Perfect
	2 v 4	1.0	Perfect
	3 v 4	1.0	Perfect
Ankle pathology	1 v 2	1.0	Perfect
	1 v 3	1.0	Perfect
	1 v 4	1.0	Perfect
	2 v 3	1.0	Perfect
	2 v 4	1.0	Perfect
	3 v 4	1.0	Perfect
Gait pathology	1 v 2	.19	Slight
	1 v 3	1.0	Perfect
	1 v 4	1.0	Perfect
	2 v 3	1.0	Perfect
	2 v 4	1.0	Perfect
	3 v 4	1.0	Perfect
Range of joint movement	1 v 2	.33	Fair
	1 v 3	.6	Moderate
	1 v 4	.37	Fair
	2 v 3	.44	Moderate
	2 v 4	.67	Substantial
	3 v 4	.44	Moderate
Shoe fit	1 v 2	.33	Poor
	1 v 3	.63	Substantial
	1 v 4	.27	Fair
	2 v 3	.51	Moderate
	2 v 4	.5	Moderate
	3 v 4	.43	Moderate
Shoe dimensions	1 v 2	.33	Fair
	1 v 3	.33	Fair
	1 v 4	.51	Moderate
	2 v 3	.43	Moderate
	2 v 4	.31	Fair
	3 v 4	.47	Moderate
Shoe condition	1 v 2	-.15	Poor (lower than that expected by chance)
	1 v 3	0	Slight (equal to that expected by chance)
	1 v 4	-.15	Poor (lower than that expected by chance)
	2 v 3	1.0	Perfect
	2 v 4	1.0	Perfect
	3 v 4	0	Slight (equal to that expected by chance)
Amount of shoe wear	1 v 2	1.0	Perfect
	1 v 3	1.0	Perfect
	1 v 4	1.0	Perfect
	2 v 3	1.0	Perfect
	2 v 4	0	Slight (equal to that expected by chance)
	3 v 4	1.0	Perfect

APPENDIX 28 Invitation to participate in the study

Letter Heading

Date

Address

Dear

I am a podiatrist undertaking a research project on shoe wear patterns at Sheffield Hallam University. In this project, I am studying the link between foot problems and patterns of wear (shoe wear patterns) seen in footprints left by shoes. I have chosen one condition in which there is a stiffening of the big toe, to study in detail.

I understand that you attend the podiatry/chiropractic service for treatment and that you may be willing to help with this study. I am seeking volunteers who would be willing to attend Central clinic for a foot assessment and interview and would ask you to bring your footwear to this interview.

If you are willing to take part in my study, please complete and return the attached form in the stamped, addressed envelope provided. I will then contact you over the next few weeks to arrange a convenient appointment time.

Thank you

Yours sincerely

Wesley Vernon
SwaMP project research student, Sheffield Hallam University.

Enc

I am willing to take part in the shoe wear pattern study

Name:

.....

Address:

.....

.....

Telephone number :

.....

APPENDIX 29 Appointment letter

Letter Heading

Date

Address

Dear

Thank you for indicating your willingness to help with my research. I have arranged an appointment for you at (time) on (date) in the podiatry/chiropractic department at Central health clinic and enclose a map showing how to get there. The examination and interview will last approximately 1½ hours and tea, coffee and biscuits will be available. If you are unable to attend, I would be grateful if you could telephone the above number to let me know.

Would you please bring all of your current footwear irrespective of condition and purpose to this appointment.

I also enclose an information sheet explaining what to expect at your appointment.

Thank you once again for your help

Yours sincerely

Wesley Vernon
SWaMP project research student
Sheffield Hallam University

Enc

APPENDIX 30 Information sheet

Information for participants in the shoe wear pattern study

What is this study about ?

The shoe wear pattern study is looking at the link between shoe wear and foot problems. If shoe wear is understood better, this may be helpful in diagnosing foot problems and in investigating footprints found at scenes of crime.

What will the study involve ?

When you attend for the appointment, it is important that you bring all of your current footwear with you. When you arrive, you will be weighed, your height measured and your feet will be examined and measured barefoot and when wearing shoes. You will also be video-recorded walking in your shoes. The footwear that you bring will be examined, measured and photographed separately. I will ask you some questions about your footwear and you will be asked to put items of footwear on and comment about their fit while standing and walking. The interview will be recorded on audio tape unless you object.

Will I be given any treatment at the appointment ?

No treatment will be given at the appointment, but if any problems are found that require immediate treatment, this will be arranged in an adjacent chiropody clinic.

Will the study be confidential ?

All information will be entirely confidential. The photographs and video-recordings made in the study are for record purposes only. They will only show your feet and legs, your face will be kept out of all pictures and you will not be able to be identified from them. All tapes will be kept confidential and anonymous to all others but the researcher and will be erased after use.

How long will it take ?

The whole process should take about 1½ hours.

What if I don't wish to take part ?

This will in no way affect the treatment you receive at the clinic.

What if I change my mind during the study ?

You have the right to withdraw from the study at any time without affecting your normal attendance at the clinic.

What if I have further questions ?

You should contact : Wesley Vernon, SWaMP project research student, on 0114 2716767

APPENDIX 31 Subject assessment form

Subject ref. no.		Name	dob / /
Address		Tel.	
Height		Weight	
H. Rig. assessment	Left	Right	
Joint movement			
Joint angle			
Standing assessment	Left	Right	
Foot length			
Foot width			
Lower limb pathologies present			
Foot type/ pathologies present			
Localized foot pathologies present			

APPENDIX 31 - contd.

Sitting assessment		Left	Right
Sites of foot pain			
Range of ankle movement	Dorsal		
	Plantar		
	Inversion		
	Eversion		
Calc. position (Inv/Ev)			
Range of forefoot movement	Inversion		
	Eversion		
F'foot position (Inv/Ev)			
Observed restricted movement in toes			
Overall mobility			
Callosities/ skin lesions present			
Walking assessment		Left	Right
Abnormalities noted			
Video recording made (tick ✓ when completed) <input type="checkbox"/>			

APPENDIX 31 - contd.






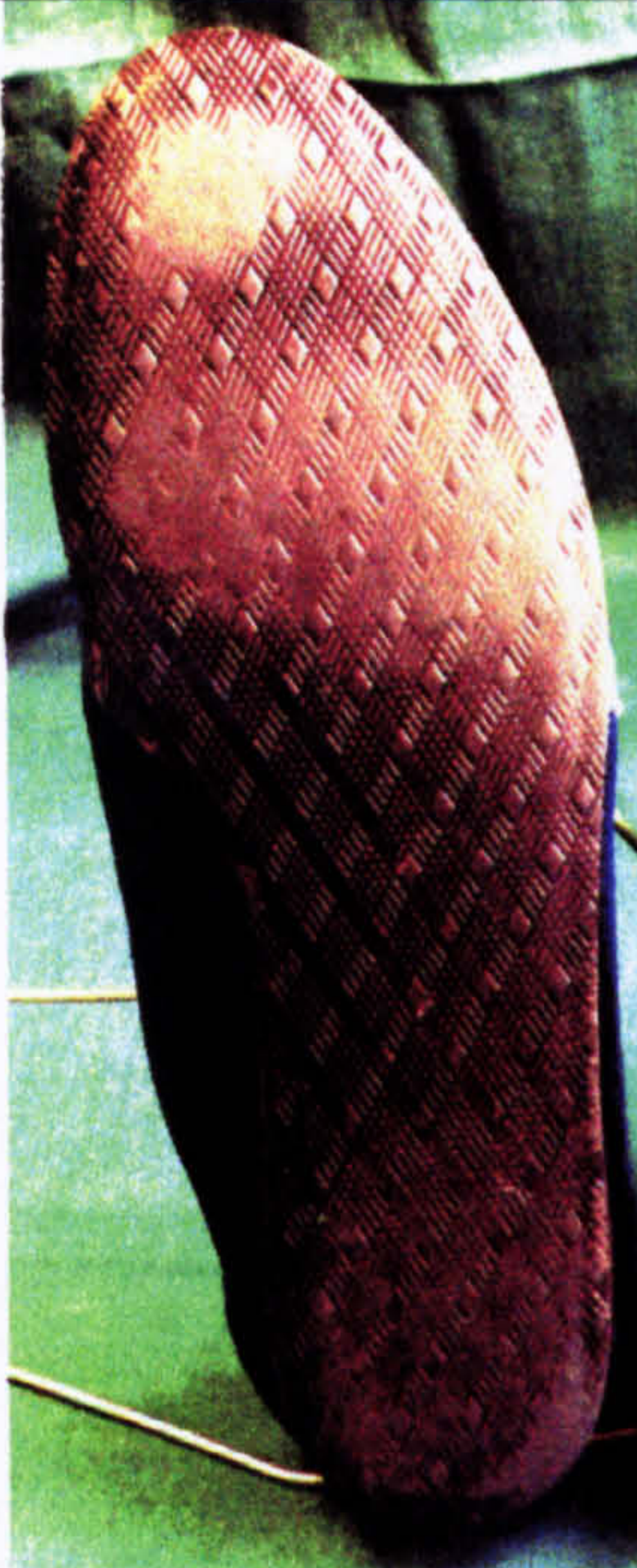


Subject ref. no.		Name	Footwear Ref. No.	
------------------	--	------------	-------------------	--

Footwear Description		
Materials		
Style		
Fastening device		
Heel height		
Sole thickness		
	Left	Right
Condition		
Marked length		
Sized length		
Marked width		
Sized width		
Depth (describe)		
Wear pattern observed (describe)		
Focal point codes		









Footwear Fit (subjective assessment)			
Length		Width	
Depth		Heel fit	
Toe box fit		Other mismatches	

Shoe outsoles photographed (tick ✓ when completed)	<input type="checkbox"/>
--	--------------------------

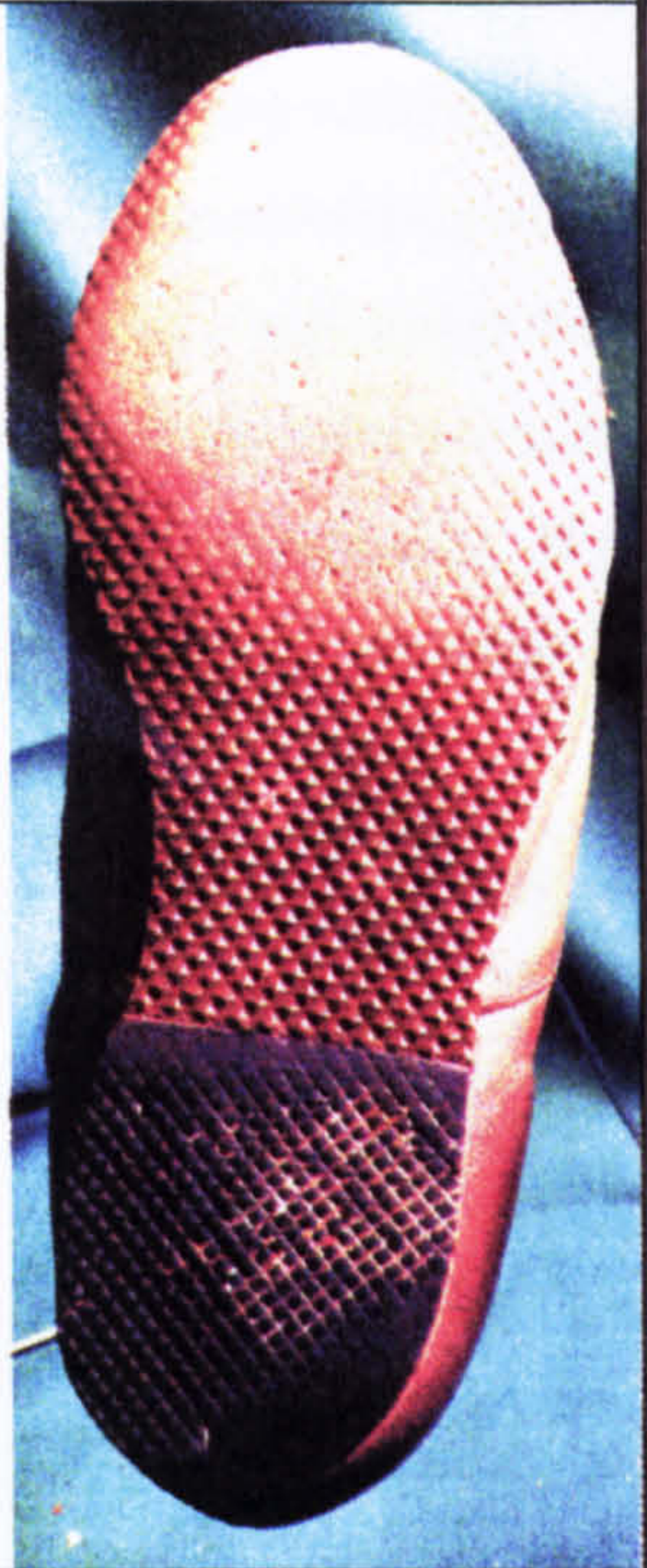
APPENDIX 32 Subject outsole wear patterns with focal codes

Subject 1			
1/1 (right)	1/1 (left)	1/2 (right)	1/2 (left)
1/13/14/15/20/21	1/13/14/15/16/20/21	Not discernible	Not discernible
			
1/3 (right)	1/3 (left)	1/4 (right)	1/4 (left)
1/3/13/14/15/20/21	1/3/13/14/15/16/20/21	1/13/14/15/18/19/21	1/13/14/15/16/20/21
			

APPENDIX 32 - contd.

Subject 2			
2/1 (right)	2/1 (left)	2/2 (right)	2/2 (left)
6/13/14/15/20/21	1/13/14/15/21	6/13/14/15/20/21	1/13/14/15/21
			
2/3 (right)	2/3 (left)	2/4 (right)	2/4 (left)
6/13/14/15/20/21	1/13/14/15/21	6/13/14/15/20/21	1/13/14/15/21
			

APPENDIX 32 - contd.

Subject 3			
3/1 (right)	3/1 (left)	3/2 (right)	3/2 (left)
6/7/14/15/16/21	6/9/15/16/21	6/7/14/15/16/21	6/9/15/16/21
			
3/3 (right)	3/3 (left)		
6/7/14/15/16/21	6/9/15/16/21		
			

APPENDIX 33 Observer questionnaire to validate video frame descriptions

Thank you for your earlier participation in the validation phase of the SWaMP project. The assessment of subjects' foot function while walking which you undertook has been collated and compared with a frame by frame examination of the video recording of that function. Various statements have been prepared to summarise the function which was believed to be shown by the video still frame sequence. You are asked to compare these statements with the relevant still frame sequences and indicate whether you agree/disagree/are unsure of each description. If you disagree with any statements given, please offer an alternative explanation of the function presented in the relevant still frame.

Thank you.

Subject one		
Subject 1 – Left bare foot observations		
Statement no.	Statement made on observed function	Agree (✓)/disagree (✗)/unsure (?)
1.	Normal heel strike	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
2.	Heel strike is followed by rapid heel eversion	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
3.	Foot abducted	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
4.	Hallux limitus restricts full foot pronation	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
5.	No attempted recovery observed from pronation	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
6.	Pronatory control is from the 1 st toe restriction alone.	
	(If <u>disagreeing</u> , please provide an alternative statement here)	

APPENDIX 33 – contd.

Subject 1 – Right bare foot observations		
7.	Normal heel strike	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
8.	Heel strike is followed by rapid heel eversion	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
9.	Foot straight, not abducted throughout stance	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
10.	Hallux limitus restricts full foot pronation later in stance	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
11.	A “classic” hallux rigidus function occurred with inversion along the 5 th MPJt., 1 st toe axis	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
12.	No abductory twist occurred	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
Subject 1 – Right shod foot observations with footwear item 1-4 (R)		
13.	The foot was clearly shown inverting throughout stance, with no medial ground contact	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
Subject 1 – Left shod foot observations with footwear item 1-4 (L)		
14.	With the shod foot, the function was not as detailed	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
15.	A normal heel strike with rapid eversion was clearly seen,	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
16.	Pronation was restricted due to the hallux limitus	
	(If <u>disagreeing</u> , please provide an alternative statement here)	

APPENDIX 33 – contd.

17.	The controlling orthotic effect of delayed eversion after heel strike could not be seen	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
	
Subject 2		
Subject 2 – Left bare foot observations		
18.	Foot abducted during stance	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
	
19.	Forefoot inverted	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
	
Subject 2 – Right bare foot observations		
20.	Foot abducted during stance	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
	
21.	With classic hallux rigidus function	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
	
Subject 3		
Subject 3 – Left bare foot observations		
22.	Both feet were seen abducting and pronating during function,	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
	
23.	With 1 st ray incompetence leading to 2 nd toe toe-off,	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
	
24.	Abductory twist was not seen in the video frames	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
	

APPENDIX 33 – contd.

Subject 3 – Right bare foot observations		
25.	Both feet were seen abducting and pronating during function,	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
26.	with 1 st ray incompetence leading to 2 nd toe toe-off,	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
27.	Abductory twist was not seen in the video frames	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
General statements		
Statement no.	Statement made	Agree (✓)/disagree (✗)/unsure (?)
28.	The freeze frame analysis showed aspects of function which could not be appreciated when viewing gait at normal speed	
	(If <u>disagreeing</u> , please provide an alternative statement here)	
Please state any further comments you may have below, continuing on a separate sheet in necessary.		
Thank you		
D. W. Vernon SWaMP project research student Sheffield Hallam University		

APPENDIX 34 Summary of observer comments on statements describing the video frame analysis

Re: Statement no. 4 – “Hallux limitus restricts full foot pronation”		
Observer no.	Disagrees/unsure	Comment
1	Unsure	Pronates (arch still lowering) into propulsive phase (after heel lift), so the q. is – would it continue to pronate at this late stage without (a H. limitus)?
2	Disagrees	Could contribute, but other structures may also have an equal role
Re: Statement no. 6 – “Hallux limitus restricts full foot pronation”		
Observer no.	Disagrees/unsure	Comment
1	Unsure	It could be 1 st toe restriction, but factors have to be considered i.e. tension in the p.f. and in this case, when pronation is occurring so late i.e. after heel lift that the supinating effect of the swing limb is responsible
2	Disagrees	Could contribute, but other structures may also have an equal role
Re: Statement no. 16 – “Pronation was restricted due to the hallux limitus”		
Observer no.	Disagrees/unsure	Comment
1	Unsure	Effects of orthoses and limited data/info. to make such a statement
2	Disagrees	Orthotics must play a role as well as other foot structures

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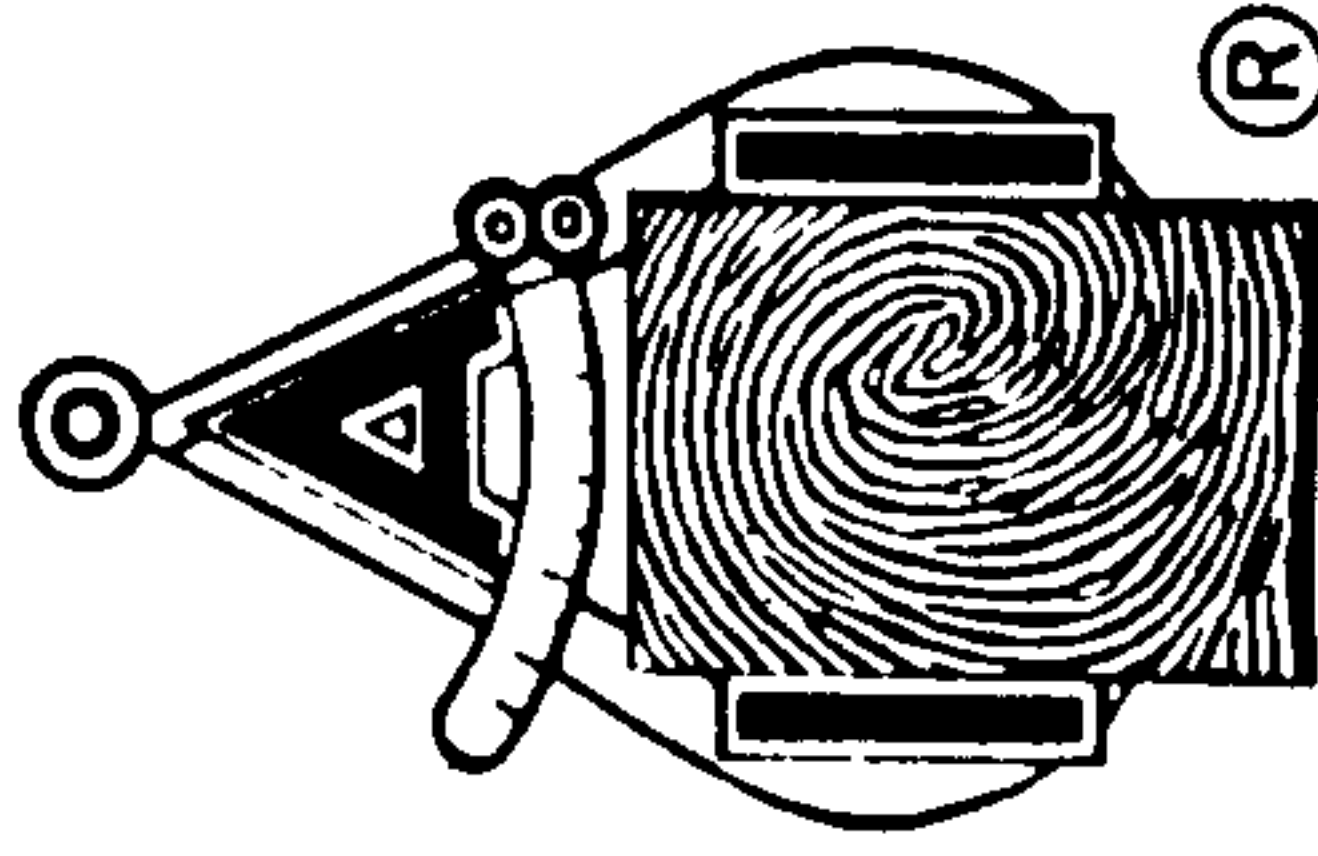
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Preliminary Findings in a Delphi Study of Shoe Wear Marks

Wesley Vernon¹

Anne Parry²

Mike Potter³

Abstract: The value of shoe wear marks as footwear evidence has long been treated with skepticism, although podiatrists are known to interpret the meaning of such marks in clinical diagnosis. Prior to the carrying out of a major study using Delphi methodology, a first round questionnaire was devised to collate experienced podiatrists' knowledge of characteristic wear marks. The results did not appear to demonstrate the level of consensus expected. Closer examination, however, indicated that there may be agreement about the meaning of specific areas of wear in the overall wear pattern shown. Reasons for the lack of overall consensus are suggested and the need for caution in the use of wear marks is reinforced pending further investigation.

Introduction

Forensic scientists have been aware of shoe wear marks for a long time, yet there is doubt as to whether these marks can be of value as forensic evidence [1]. Consequently, although it is thought that these marks represent important information about the owner of a worn shoe [2], they are of limited use in forensic investigations. Conversely,

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experienced podiatrists use shoe wear marks as an aid to clinical diagnosis and early chiropody and similar texts contain reference to wear mark interpretation, including diagrammatic representations of wear marks stated to be characteristically caused by named pathological conditions [3, 4, 5, 6].

In 1967, L. J. Lucock, an English chiropodist, published a paper on identification from footwear illustrated with wear marks related to given pathologies [7]. These published references, however, were based on clinical observation combined with experience, and it is assumed that podiatrists' clinical use of wear marks is founded on a knowledge base derived from personal experience. In common with other health professions, the knowledge base of podiatry is growing rapidly. Parry and Stone [8] pointed out that the characteristics of knowledge underpinning physiotherapy practice are unclear and the process whereby the knowledge of a practitioner is developed from the theoretical frameworks provided by scientific disciplines and from experience is not understood. Rules of thumb, reasoned guesses, insight, informed opinion and identification of exceptions to the rule all contribute to clinical expertise.

Knowledge is hidden in many ways and there is a need to retrieve informal knowledge about podiatry so that it can be transferred to students. Elicitations of knowledge about shoe wear marks will either confirm or deny that they can be used with a degree of certainty in clinical diagnoses and forensic investigations and should be taught to students. On this basis, a Delphi study was planned to collect experts' knowledge of characteristic shoe wear marks.

The Delphi technique

The Delphi technique is a method of obtaining the most reliable consensus of a group of experts via several rounds of questionnaires. It was devised by the Rand Corporation in the 1950s to predict effects of a nuclear war [9], but due to the secretive nature of this work, publication was delayed for ten years. The technique has become widely adopted by the health care professions since 1975 when it became widely used by the nursing profession. Of the many benefits derived from the use of the Delphi technique, the method was chosen for this study because:

- Experiences stated by those questioned have not been influenced by others;
- The technique allows access to large numbers of experts across widespread locations;
- Group consensus is possible;
- The technique is time efficient;
- All responses carry equal weighting;
- Overview is achieved after round one;
- Key issues are produced;
- The technique is simple to use;
- Participants' abilities are fully used;
- The technique usually produces good response rates.

The stages of the Delphi technique include devising the research question, choosing enough suitable participants to ensure study feasibility, noting and matching subsequent responses and final presentation, explanation and analysis of results.

As it was intended to include every U.K. National Health Services Trust with a Podiatry Department in the Delphi study, a pilot Delphi was seen to be essential in order to test the proposed method.

Aim

The aim of the pilot study was to test the suitability of the Delphi method for collecting expert knowledge on characteristic shoe wear marks in the form of a wide range of wear mark patterns together with their stated cause and to seek consensus over this knowledge.

Method

The Delphi Round 1 was devised to collect experts' knowledge gained through interpreting shoe wear patterns characteristically associ-

ated with named structural or functional disorders of the foot, lower limb, or type of gait.

Sample

Ten U.K. Health Trusts volunteered to assist with the Pilot Delphi with each Professional Head of Service nominating their most experienced podiatrist to take part in the study.

Questionnaire

The questionnaire itself asked respondents to mark on blank outsole outlines a maximum of 10 characteristic patterns with which they were familiar through experience and to name the condition associated with that pattern.

Procedure

The questionnaire was distributed to the participating Trusts together with several items of supportive information including a covering letter, explanatory notes, an example sheet and a comprehensive "prompt" list of possible pathologies. A feedback sheet and return envelope were also included.

Analysis

The returned wear mark patterns were initially collated and stored under pathology headings. Patterns given under each heading were scrutinized for similarities and agreements and common patterns under each heading were recorded diagrammatically and prepared for returning to participants in order to seek a future consensus agreement.

Results

There was a 70% response rate achieved in Round 1 of the Pilot Study. The returned information, however, yielded unexpected results. The given patterns related to a total of twenty nine different pathological states (Diagram 1). Wear patterns for thirteen of these pathologies were identified by more than one respondent and could therefore be examined for consensus. These patterns are depicted in figure 1. Twelve patterns were recorded for Calcaneo-Valgus/pronation (figure 1.1), five for Hallux Rigidus (figure 1.2), three for shuffling gait in

Figure 1 (1.1)

Shoe wear mark patterns depicted by podiatrists for conditions that received more than one response

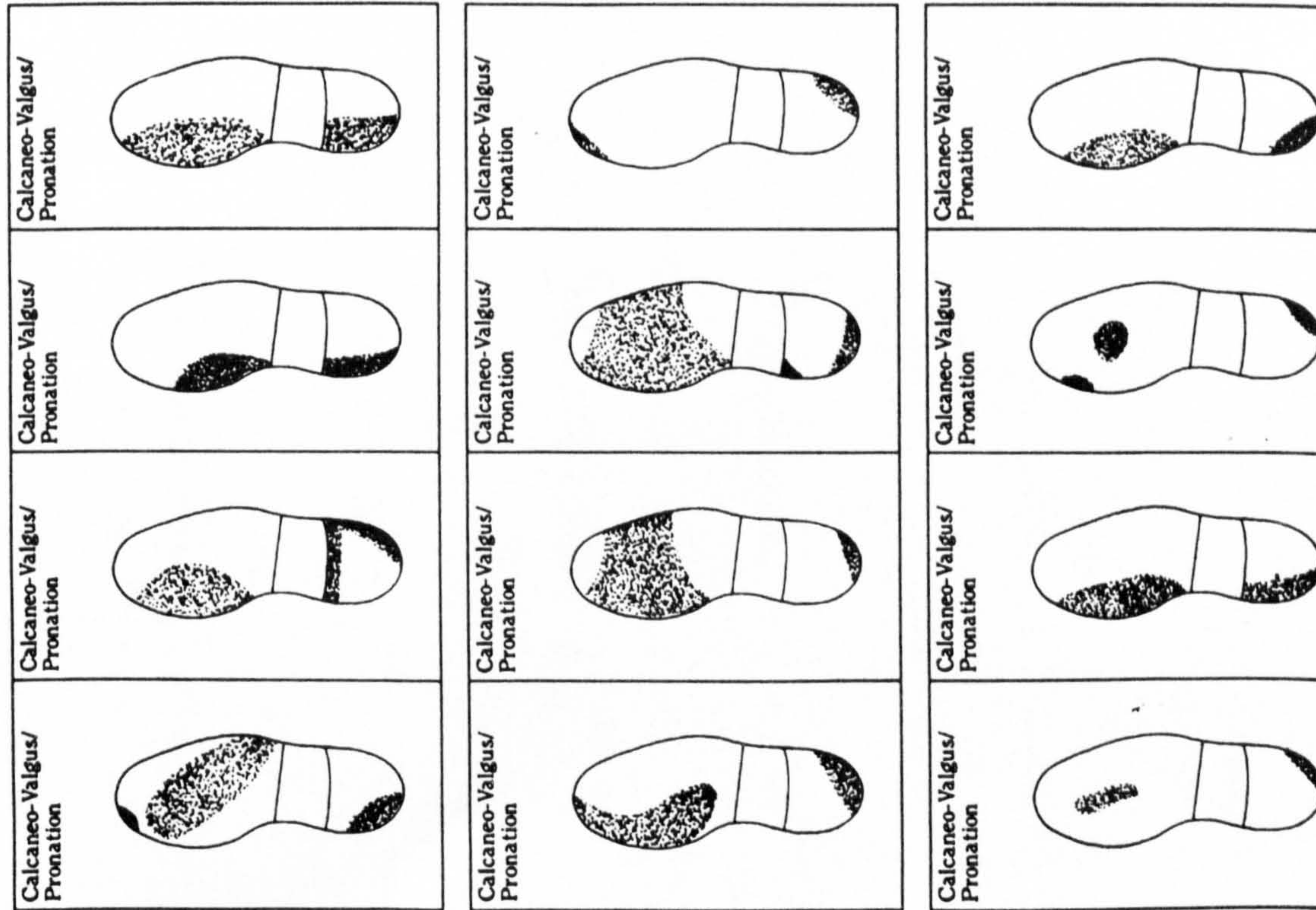


Figure 1 (1.2)

Shoe wear mark patterns depicted by podiatrists for conditions which received more than one response

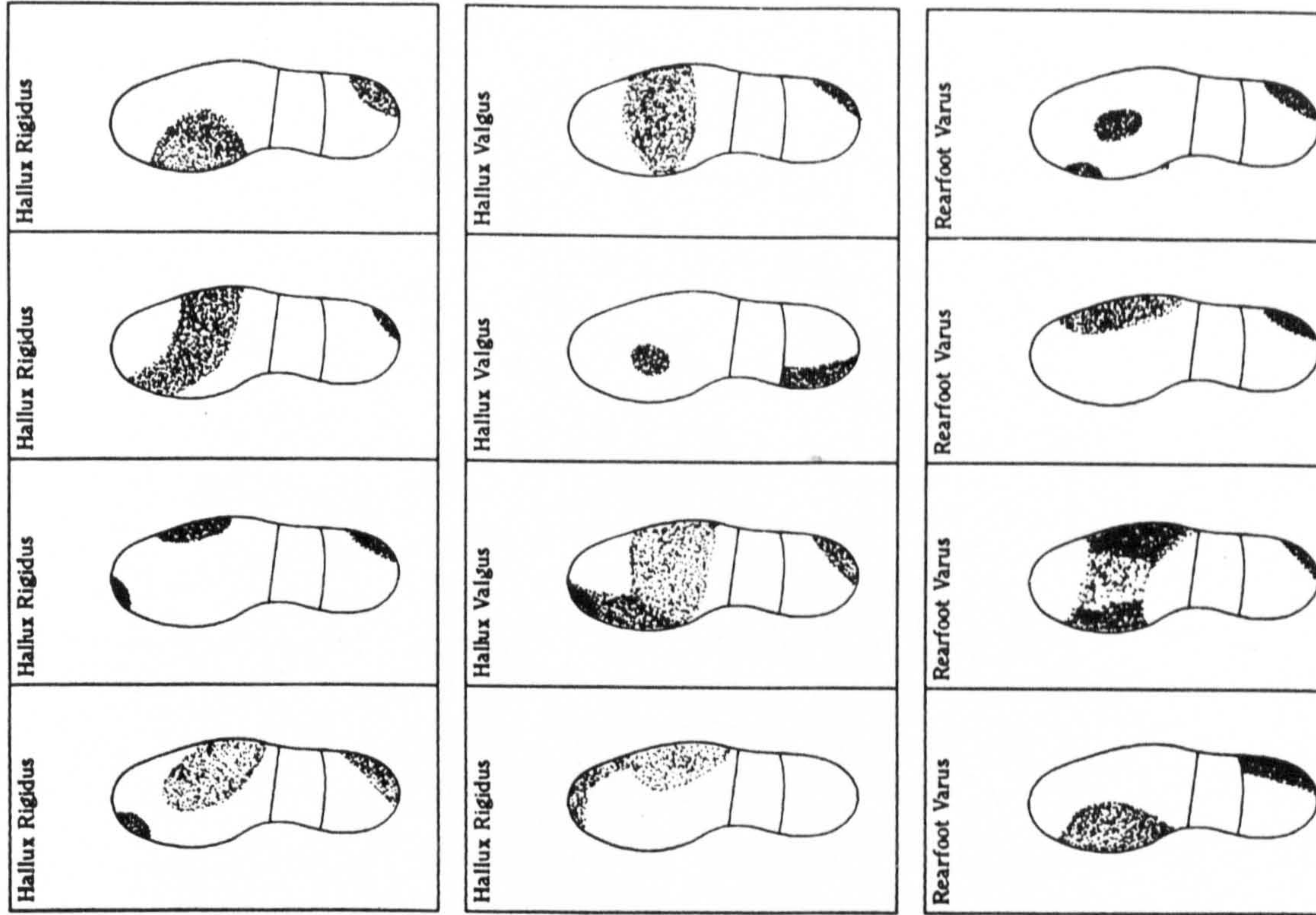


Figure 1 (1.3)

Shoe wear mark patterns depicted by podiatrists for conditions which received more than one response

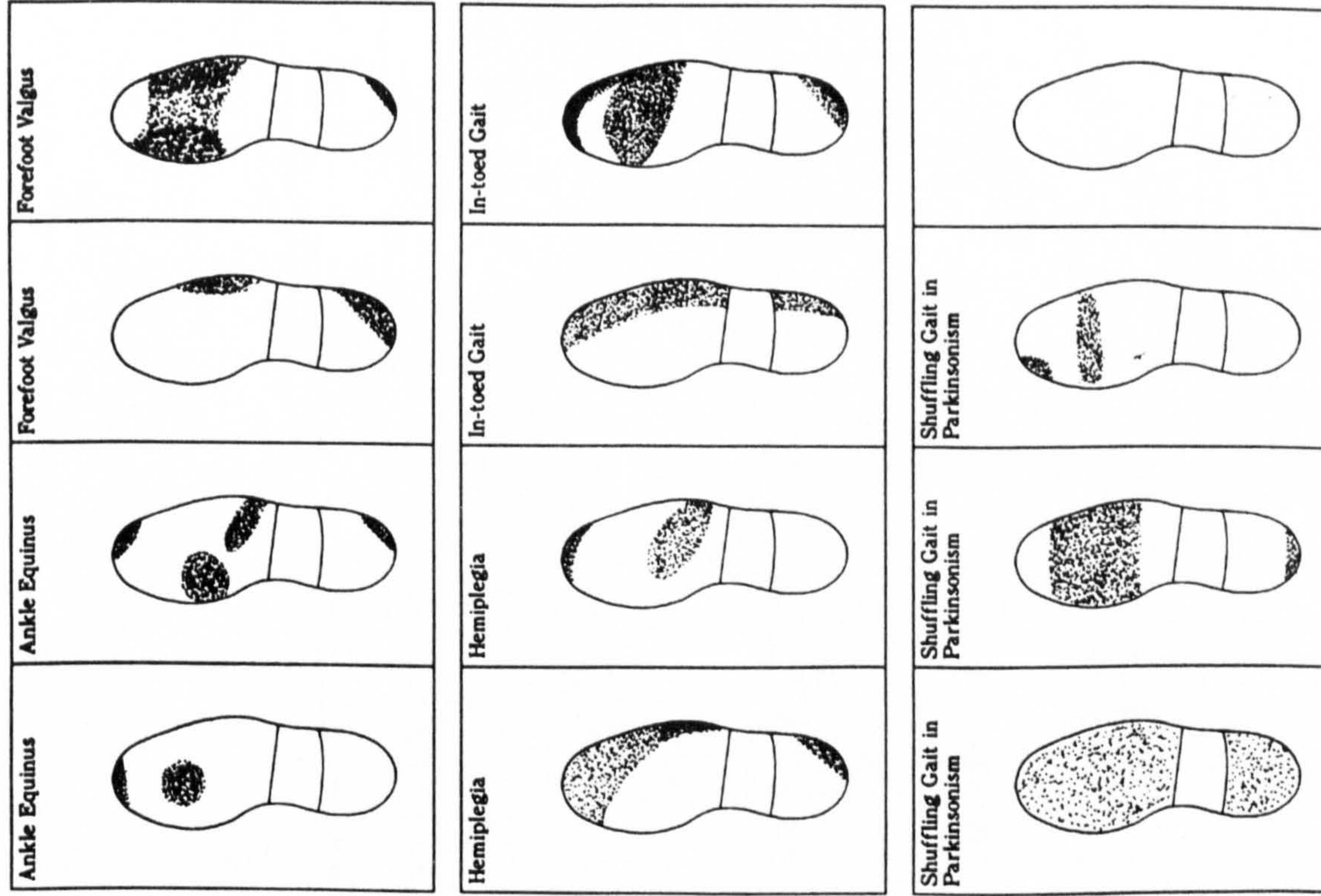
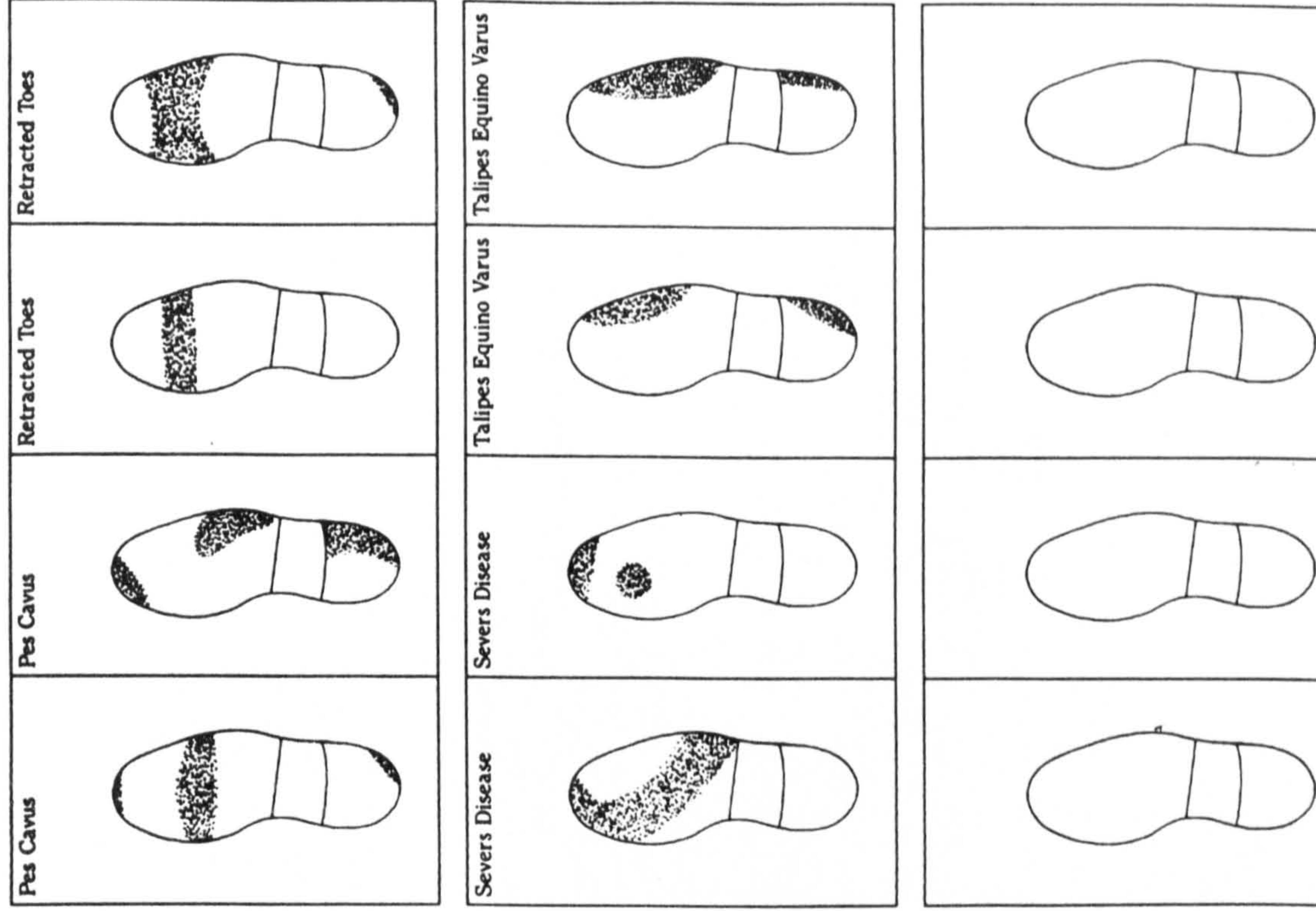


Figure 1 (1.4)

Shoe wear mark patterns depicted by podiatrists for conditions which received more than one response



Parkinson's disease, and two each for ankle equinus, forefoot valgus, hemiplegia and in-toes gait (figure 1.3) and two each for pes cavus, retracted toes, Severs disease and talipes equino varus (figure 1.4).

Initially it appeared that the majority of patterns stated under each pathology heading had no consensus whatsoever. Close scrutiny however indicated that there could indeed be a number of common wear areas suggested by respondents under each heading. These commonalities related to single aspects of the entire pattern shown. This is to say that although there was no consensus suggested with regard to the entire pattern, a consensus view existed over certain single aspects of the pattern. These common features are recorded in Diagram 2.

Discussion

The results themselves indicate six possible interpretations. While poor agreement over the totality of patterns was initially of concern, close scrutiny revealed consensus over specific areas of wear under stated headings. The six possible conclusions are:

- 1. The task was too difficult. That is, while we recognize patterns, we are unable to draw good likenesses of these patterns.
- 2. There was no consensus over patterns because the respondents did not possess the knowledge required.
- 3. There was no consensus over patterns because wear marks have no relationship to underlying states.
- 4. There was no consensus over patterns because even though wear marks could have a relationship to underlying states, there are too many variables present to be able to place a meaningful interpretation on these wear marks. Examples of such variables are shoe type, last type and shoe sole material.
- 5. There was no consensus over patterns because there are regional variations to be seen in wear mark patterns as related to defined states - i.e. the characteristic wear pattern will vary according to where an individual resides due to geographical, industrial, or socio-economic factors.

- 6. There is potential for consensus shown in the results but this is related to specific areas of the pattern as opposed to the entire patterns. For example, although only 3 of the 12 patterns shown for Calcanco Valgus appeared to be the same, eight respondents agreed that there would be wear along the entire medial sole area. This implies that some of the specific wear areas may relate to general function or secondary pathologies: In a total wear pattern some of the wear could be caused by the normal walking process, some could be characteristic of the pathological state of the foot and some could be due to secondary complications of that pathology. If this is the case, respondents could have misinterpreted the overall pattern while still identifying the specific wear area relating to a particular condition. This may also be related to hemispheric asymmetries in cognitive style. That is, the right cerebral hemisphere of the brain is more holistic and recognizes form and shape, whereas the left cerebral hemisphere is more sequentially analytical. Thus the right hemisphere recognizes a whole pattern and the left attends to the separate parts.

It is felt that lack of knowledge is not the reason for the differences because different patterns were presented even for very common, easily diagnosed conditions (e.g. Hallux Rigidus, Hallux Valgus). If further investigation still leaves this suggestion as a possibility, then a testing of knowledge may be required, possibly covering the currently known "experts" in this field.

With regard to the idea that wear marks have no relationship to underlying states, this is a highly unlikely conclusion. Studies using force plate technology have shown that characteristic motions and pressure patterns arise during gait cycles relating to specific states [10]. If characteristic force and pressure pathways exist it must necessarily follow that any interface (shoe sole) between the pressure source (foot) and the ground must be affected in a similar way on each occasion that this interface is subjected to a characteristic pressure pattern.

Wear marks are the product of usual, not variant footsteps. However, extraneous variables can have an effect on shoe wear patterns. Shoe soles can be manufactured from different materials which can wear at different rates and it is also conceivable that if the material is hard enough, foot function may be corrupted. The style of shoe may

also have a role to play in altering function. A well designed trainer that allows full foot function may in turn allow a different characteristic representation of wear marks than a shoe which through different heel height, slip-on nature and forefoot and toe restriction may influence the foot function to an extent that the wear mark alters.

If a shoe is too small or too large, then this may also affect foot function. Different last types exist, such as straight last and curved lasts, upon which shoes are manufactured. It is therefore feasible that shoes manufactured on different lasts may exert control over foot function in different ways, therefore also affecting wear mark patterns. However, as shoes are "worn in", the usual footstep will begin to produce the characteristic patterns for that foot/shoe relationship.

Despite the possibility of these variables affecting foot function and shoe wear marks, this may not account for the lack of consensus observed. Information given was based on clinical experience. Despite the presence of possible confounding factors, experience would be based on repeated observations over several years. If the observations are repeated, they have been observed on many occasions irrespective of these factors which may not be known by the observers. Investigation into variable effects may however be required at some stage although the project is only attempting to determine whether there is broad pattern agreement.

Regional factors may certainly have a part to play in confounding consensus. This is a novel suggestion which may account for some of the disagreements currently in existence regarding bio-mechanical theory. This does not, however, take into account the fact that respondents may have worked and studied in several different areas and Schools of Podiatry and subjects alike may have exhibited varying degrees of mobility around the U.K. throughout life. If lack of consensus continues in later Delphi Rounds, this will be an area requiring further investigation, possibly by collecting data from defined areas by direct observation and recording methods.

The Round 1 Delphi Pilot results have raised a number of questions regarding the issue of wear marks. The limited number of consensual replies received was inevitable in a Pilot Test where free expression is given yet limited to a maximum of ten suggestions. The amount of commonality shown, however, has been adequate for the purpose of this Pilot Round which aimed to test the method for potential problems

and to investigate a limited number of areas for consensus and these objectives have been achieved.

An interesting point is that two respondents showed patterns for Severs disease, one respondent showed a pattern for Freibergs Infracture and one respondent showed a pattern for Charcot-Marie-Tooth disease. None of these conditions is common and would not have been expected in a list based on familiarity by experience. An influencing factor could have occurred, however, in that when an unusual feature is encountered clinically, the clinician may then retain far more detail about that condition than usual through greater interest being generated by such an interesting case. This influence would be helpful in the main data collection phase as it may pull in data otherwise overlooked. The minimal pattern consensus was not expected, but as stated, when the data is scrutinized in detail, consensus about specific areas in overall patterns can be seen. This possibility now requires further investigation.

Limitations of study

A number of minor administrative problems became apparent with the questionnaire which will be addressed before the main Delphi Round 1 is undertaken and feedback comments were very helpful in this respect.

Conclusion

A number of conclusions can be drawn from Delphi Pilot Round 1 as follows:

- The Pilot Round collected the information sought successfully. The information was not that which had been expected in that there initially appeared to be widespread lack of consensus. This will need to be investigated.
- The Delphi Pilot showed some sensitivity to capturing useful data on obscure conditions.
- The lack of apparent consensus appears to warrant investigation but it would be sensible first to investigate the possibility that there may be consensus relating to specific wear

areas. If there still proves to be lack of consensus, then experts must be tested to see if any expertise exists in this field at all. If so, other influencing factors must be investigated.

- At some stage, investigation into variable effects of footwear styles, materials and occupational factors may be required.

Although preliminary, the results reinforce the view that care should be taken in using outsole wear marks in forensic investigations until more information becomes known through sound research.

It is therefore concluded that as a follow up to this Pilot Delphi Round 1, a Delphi Pilot Round 2 should be commenced, amending the format where necessary to take account of recommendations. This round should have the aim of determining consensus (if possible) over specific wear areas as opposed to seeking consensus over the broad patterns shown initially under each structural/functional heading. This round would therefore only involve states for which more than one pattern has been given in Round 1. If consensus is not ultimately found, then the suggested reasons for this must be investigated. If the series of preliminary studies suggests that consensus is indeed possible, then a major study across the U.K. on the same basis will be initiated.

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Diagram 2.

	No. of responses showing wear in each given area of the sole (shown in brackets as % of total patterns received for each pathology)															
Pathology	Toe areas				Metatarsal head areas				Heel areas							
	Apex of 1st	Apex of 2,3,4	1st	5th	1st	2nd/3rd	4th	5th	Anterior	Anterior medial	Anterior lateral	Posterior medial	Posterior lateral	Central	Posterior	
Calcaneo-valgus/ Pronation	6 (50%)		8 (66%)		8 (66%)	5 (42%)	3 (25%)	3 (25%)	1 (8%)	5 (42%)		5 (42%)			3 (25%)	
Hallux Rigidus	4 (80%)			2 (40%)	1 (20%)	3 (60%)	3 (60%)	4 (80%)					5 (100%)			
Rearfoot Varus			3 (75%)	2 (50%)	4 (100%)	3 (75%)	1 (25%)	2 (50%)			1 (25%)		4 (100%)			
Hallux Valgus	1 (33%)		1 (33%)	1 (33%)	2 (66%)	3 (100%)	2 (66%)	2 (66%)		1 (33%)		1 (33%)	2 (66%)			
Parkinsons (shuffling gait)	2 (66%)	1 (33%)	2 (66%)	2 (66%)	3 (100%)	3 (100%)	3 (100%)	3 (100%)	1 (33%)	1 (33%)	1 (33%)	1 (33%)	1 (33%)	1 (33%)	2 (66%)	
Retracted toes					2 (100%)	2 (100%)	2 (100%)	2 (100%)					1 (50%)			
Ankle Equinus		2 (100%)				2 (100%)		1 (50%)					1 (50%)			

Diagram 1.

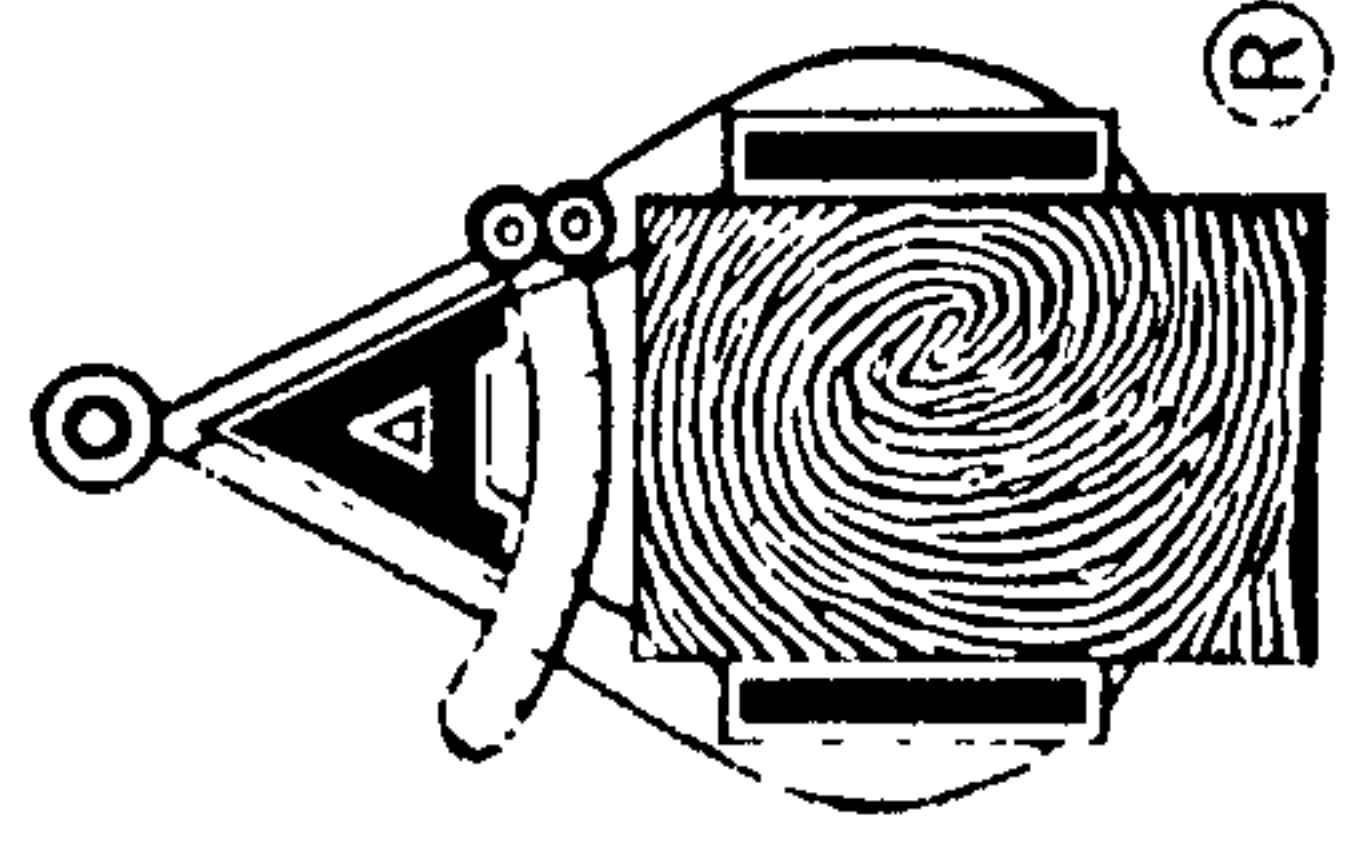
Condition/state	No. of responses	Condition/state	No. of responses
Calcaneo-valgus pronated foot	12	Charcot-Marie-Tooth disease	1
Hallux Rigidus	4	Claw toes	1
Rear foot Varus	4	Foot drop	1
Hallux Valgus	3	Frederick's Varus	1
Parkinsonism	3	Frederick's entrapment	1
Ankle Equinus	2	Varus Valgus	1
Frederick's Valgus	2	Varus Valgus	1
Hemiplegia	2	Hammer 2nd toe	1
In-toed gait	2	High stepping gait	1
Flat Foot	2	Hypermobile 1st and 5th metatarsals	1
Retracted toes	2	Neuropathic Ulceration	1
Severe disease	2	Flat foot gait	1
Flatfoot Equinus Varus	2	Rheumatoid arthritis	1
Neurotic Gait	1	Short 1st metatarsal	1
Charcot Joint	1		

Diagram 2 (contd.)

Pathology	No. of responses showing wear in each given area of the sole (shown in brackets as % of total patterns received for each pathology)														
	Toe areas				Metatarsal head areas				Heel areas						
	Apex of 1st	Apex of 2,3,4	1st	5th	1st	2nd/3rd	4th	5th	Anterior	Anterior medial	Anterior lateral	Posterior medial	Posterior lateral	Central	Posterior
Forefoot Valgus	1 (50%)		1 (50%)	1 (50%)	1 (50%)	1 (50%)	1 (50%)	1 (50%)					2 (100%)		
Intoed Gait		2 (100%)		1 (50%)		1 (50%)	1 (50%)	2 (100%)			1 (50%)		2 (100%)		
Talipes Equino Varus				2 (100%)		1 (50%)		2 (100%)			2 (100%)		1 (50%)		
Severs Disease	1 (50%)	2 (100%)	1 (50%)			2 (100%)	1 (50%)	1 (50%)							
Hemiplegia		2 (100%)		1 (50%)		1 (50%)	1 (50%)	2 (100%)					1 (50%)		
Pes Cavus	1 (50%)	2 (100%)			1 (50%)	1 (50%)	1 (50%)	2 (100%)			1 (50%)		2 (100%)		

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Moving Towards Consensus: The First Draft of an Evaluative Instrumental Grid to Interpret Shoe Wear Patterns

Wesley Vernon¹

Anne Parry²

Mike Potter³

Abstract: In a first round pilot Delphi study of podiatrists' experiences of shoe wear marks, considerable lack of agreement had been noted among participating podiatrists. A second Delphi round has now been carried out. This second Delphi round showed a moderate move towards consensus among participating podiatrists in the context of overall wear interpretation. When chosen wear patterns were examined more closely, however, hidden agreements were found with regard to specific areas of wear – the focal points from which the wear was spreading. These focal points can be diagrammatically represented on a drawing of a shoe outsole with identifying numbers ascribed to each such point. When this analytical grid was used on depictions of wear patterns chosen by second round respondents, the location codes were found to be specific for the conditions to which the wear related. This preliminary grid may form the basis of the first "measuring" device capable of translating and giving meaning to shoe wear marks.

Introduction

In a Delphi study of podiatrists' experience of shoe wear marks, unexpected lack of agreement had been observed in the first round [1]. The data provided by participating podiatrists had been based on their

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many clinical observations over a number of years and supported the current belief that wear marks are of doubtful value to forensic investigators due to the many variables acting on the shoe outsole.

As past errors have been made with regard to wear mark interpretation in forensic investigations [2], the findings had been considered to be sufficiently important to be submitted for early publication [1]. When the data in this Round 1 Delphi study was examined in greater depth however, the possibility of a hidden consensus had been noted. Where participating podiatrists were in general disagreement over the overall pattern relating to specific foot/gait conditions, there had appeared to be some agreement over specific components of wear relating to each condition.

It had also been noted in this study that podiatrists had shown that specific patterns could be caused by a number of different foot conditions. In order to explore this further and seek a basis for consensus, a follow-up Delphi round was planned. This would test participant's strength of belief over which conditions could be associated with specific wear patterns where multiple suggested causes had been made. It would also test the level of agreement over specific areas of wear within an overall pattern being common to a specific condition.

Method

Information received in Round 1 was presented again to participants as a Delphi Round 2 questionnaire. In this, the Podiatrists were asked to associate wear patterns and wear pattern components with named conditions which had arisen on Round 1. In doing this, consensual agreement was sought over two specific aspects of the Round 1 data for which two Round 2 questionnaire sections were planned.

Section 1

In this first section, those patterns which had been shown as having several different possible causes in Round 1 (diagram 1) were presented again and respondents asked which of the conditions named could lead to that pattern. The patterns involved were reproduced on the questionnaire sheet along with the conditions which had been named by respondents in Round 1 as being related to these patterns. Respondents were asked to indicate which of the possible conditions they believed would cause the wear patterns shown and they were advised that they were not

Diagram 1

Section 1 of the Delphi Round 2 Pilot Questionnaire

Wear patterns given in Round 1 under more than one 'pathology' heading.
Please tick ✓ relevant boxes.

PATTERN 1. 	PATTERN 2. 	PATTERN 3. 	PATTERN 4.
-----------------------	-----------------------	-----------------------	-----------------------

Diagram 1 (continued)

PATTERN 5. 	PATTERN 6. 	PATTERN 7. 	PATTERN 8.
PATTERN 9. 	PATTERN 10. 	PATTERN 11. 	PATTERN 12.

Diagram 2 (continued)

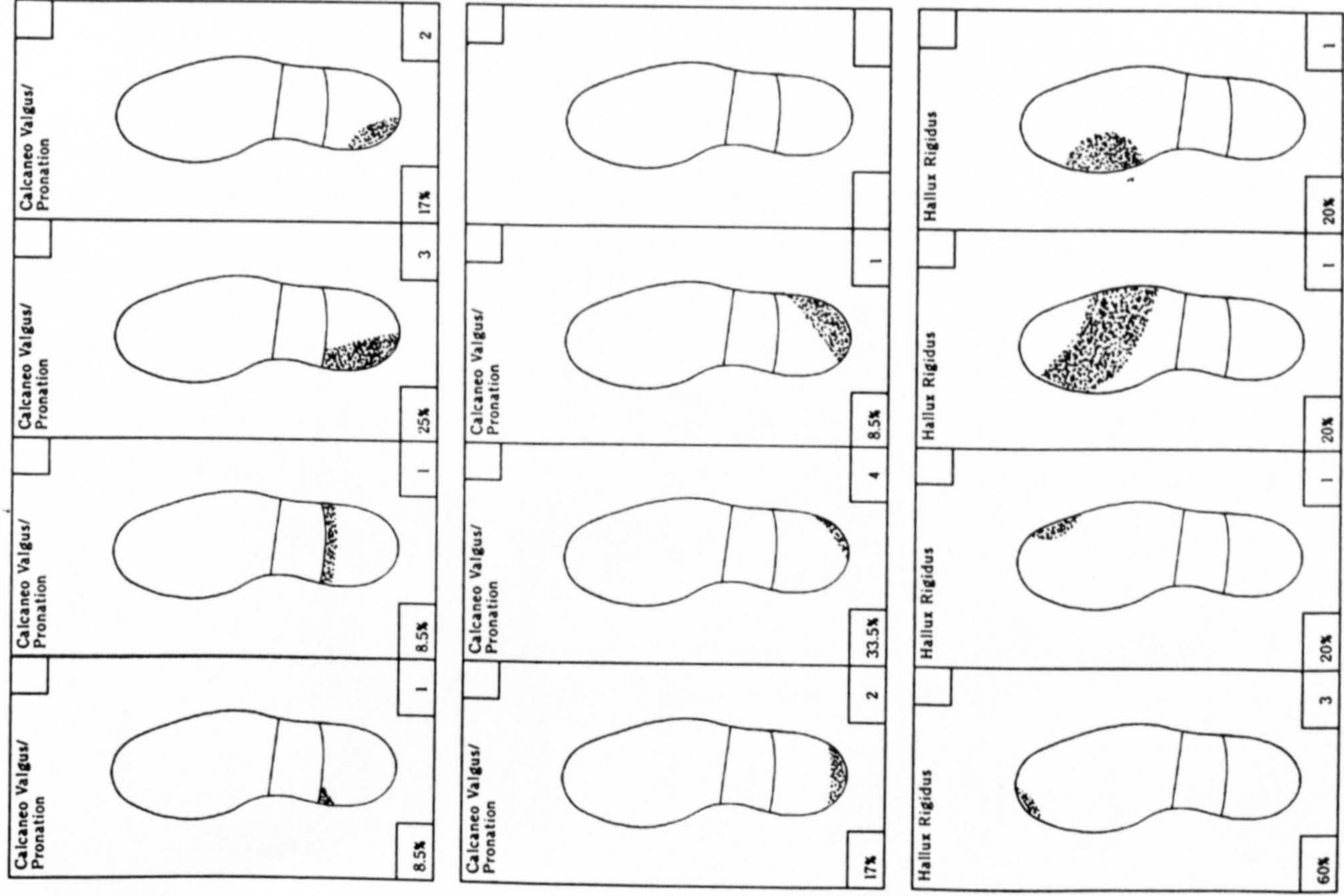
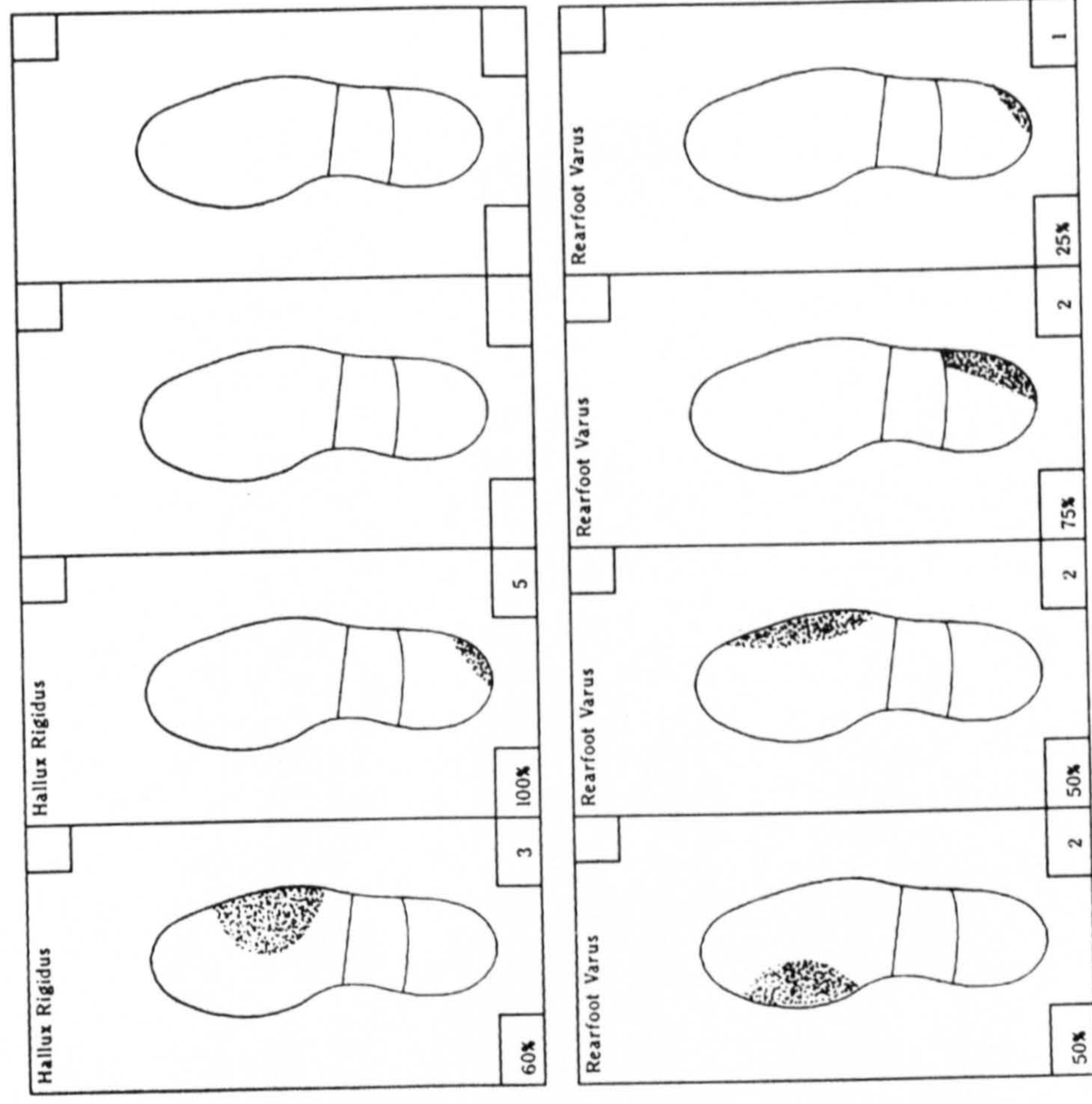


Diagram 2 (continued)



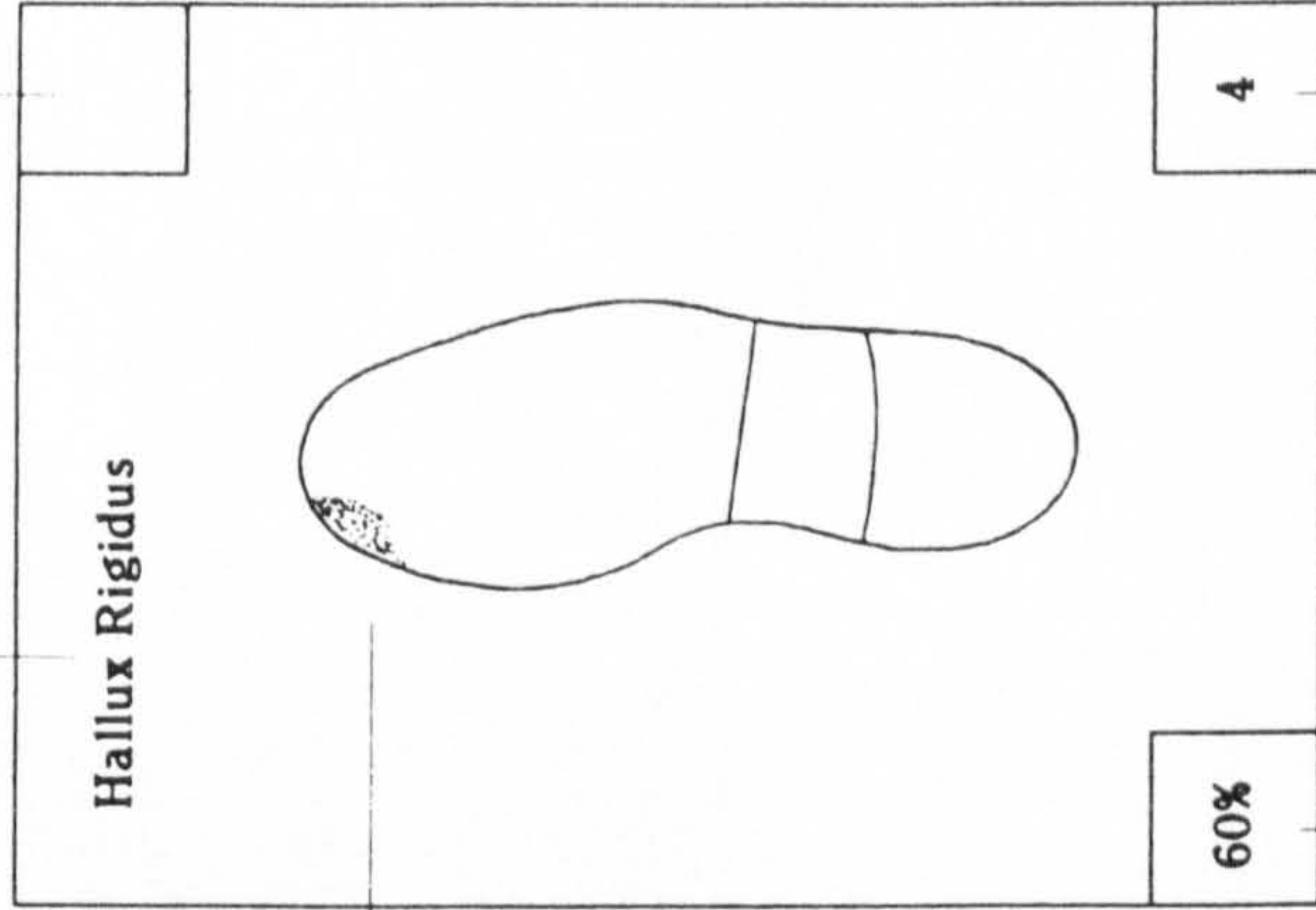
Levels of consensus in Section 1

Key to Section 2

Wear area component as part of the total pattern for the named condition

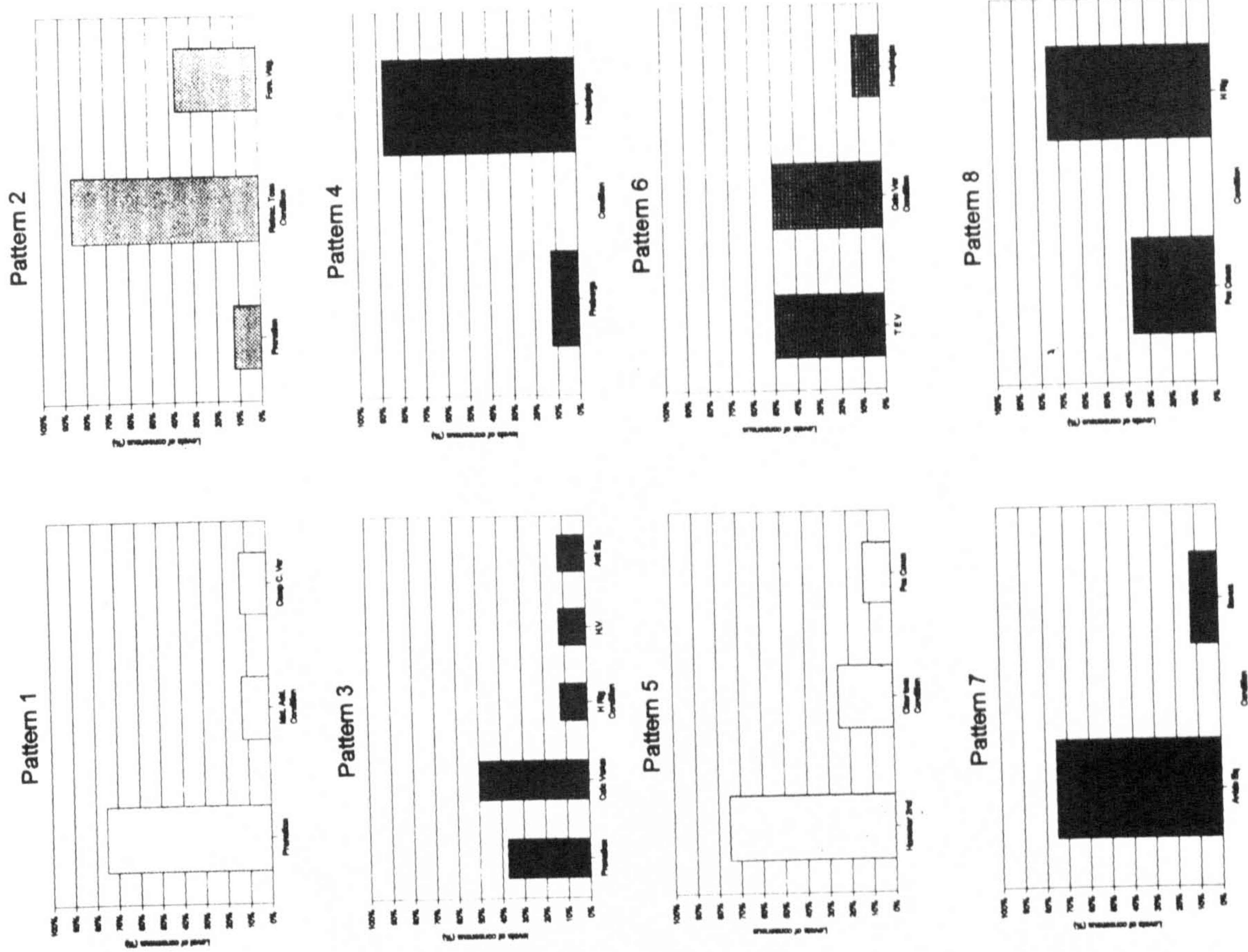
Name of condition

Put a tick (✓) in this box if you agree that this is a wear area component of the characteristic pattern related to the named condition

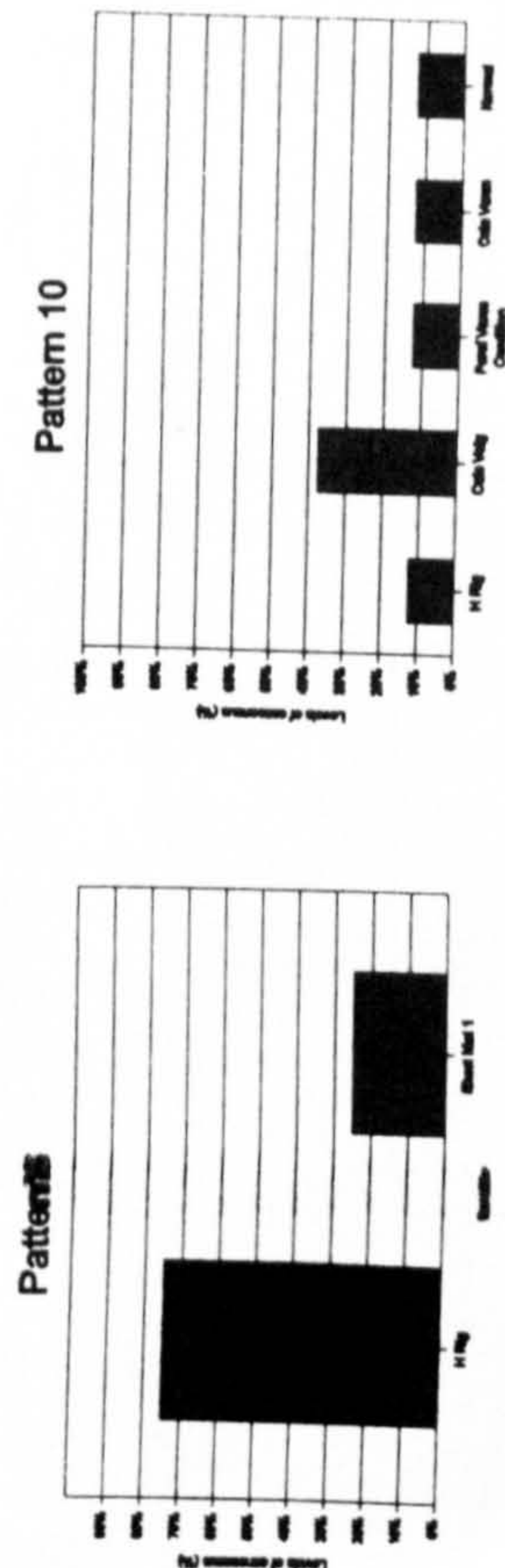


Percentage of respondents in Delphi 1 who having shown a wear pattern for the named condition indicated wear in this area

Of the 7 round 1 respondents, actual number who included wear in this area



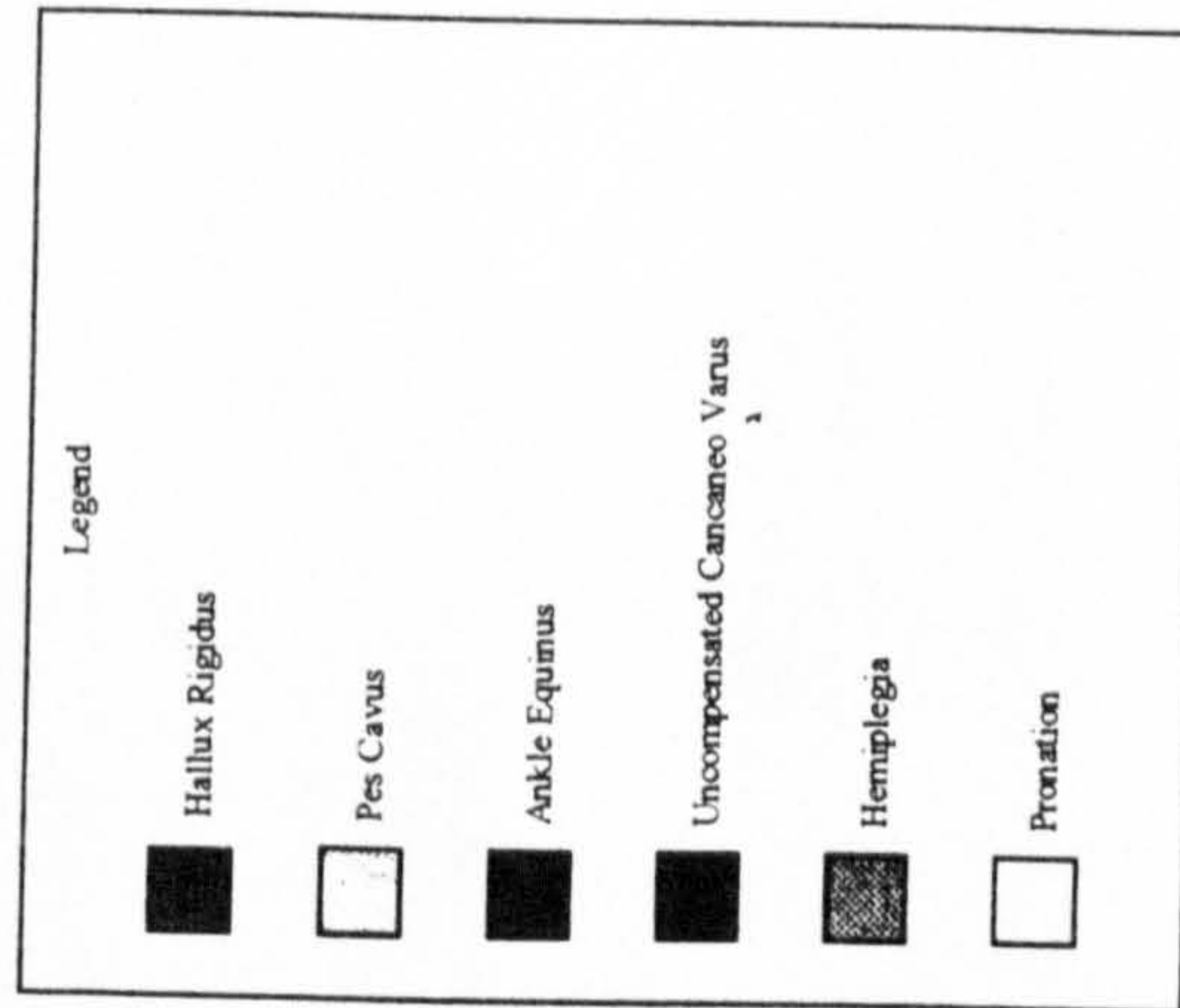
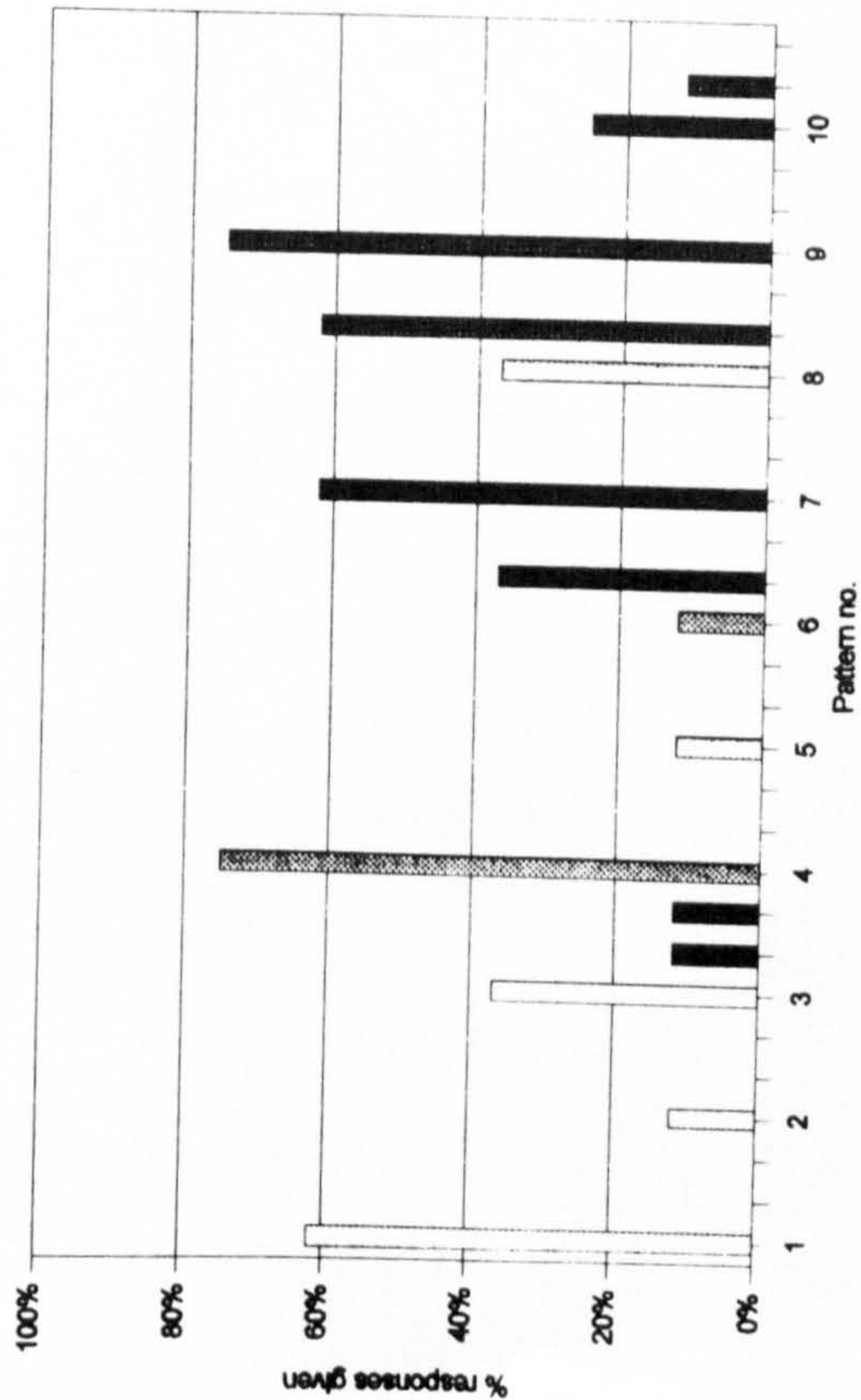
Patterns for which additional causative conditions were suggested in Round 2



Pattern and number	Additional suggested causative conditions	Pattern and number	Additional suggested causative conditions
1	Partially compensated Rearfoot Varus.	3	Ankle Equinus Hallux Rigidus Hallux Abductor Valgus.
5	Pes Cavus	6	Hemiplegia
10	Forefoot Varus Rearfoot Varus Normal Foot		

Graph 2

% response by condition and pattern



Section 2

There was 100% agreement that two of the separate pattern components shown for Calcaneo Valgus/Pronation and Rearfoot Varus were related to the associated condition and four of the depicted pattern components were not acknowledged by any of the participants (graph 3). Twelve of the pattern components had increased recognition from Round 1, five remained the same and seven had decreased.

Analysis

Although it had been noted in Round 1 that while different, the wear mark patterns offered by participants covered a number of common areas of the shoe sole, the consensual levels achieved in Round 2 Section 2 showing separate wear components were only moderate.

When the replies were studied in greater depth however, agreements emerged. The wear components offered in Section 2 were of diverse shape, but it was noted that very specific outsole locations were common to several of these components. These location points could be described verbally by relating them to the overlying foot anatomy (e.g., tip of 1st toe, 1st metatarso phalangeal joint, etc.) and reflected the areas from which wear would be spreading. A list of these points was drawn up and extended by drawing on clinical experience to include other possible locations of the outsole which could act as focal points of wear and an identifying code number was allocated to each point (table 2).

An analytical "grid" was drafted on the basis of these focal points (diagram 3). The less precise grid point representing the second/third metatarso-phalangeal joint area represents the difficulty in locating these specific anatomical points from the outsole. When this grid was applied to patterns and pattern components depicted in Round 2, those patterns could be represented by a grid code locating the grid points from which each area of wear in the patterns would be spreading.

For example, in Pattern 7, wear was radiating from the 2nd/3rd metatarso phalangeal joint area (represented by Code 15) and from the tips of the 2nd, 3rd and 4th toes (represented by Code 21). Pattern 7 would therefore be represented by a grid code of 15/21 (diagram 4). The codes for all patterns in Section 1 and pattern components in Section 2 are given in tables 3 and 4. When this draft analytical grid was used to "measure" the depicted wear pattern components shown in

Graph 3

Levels of consensus in Section 2

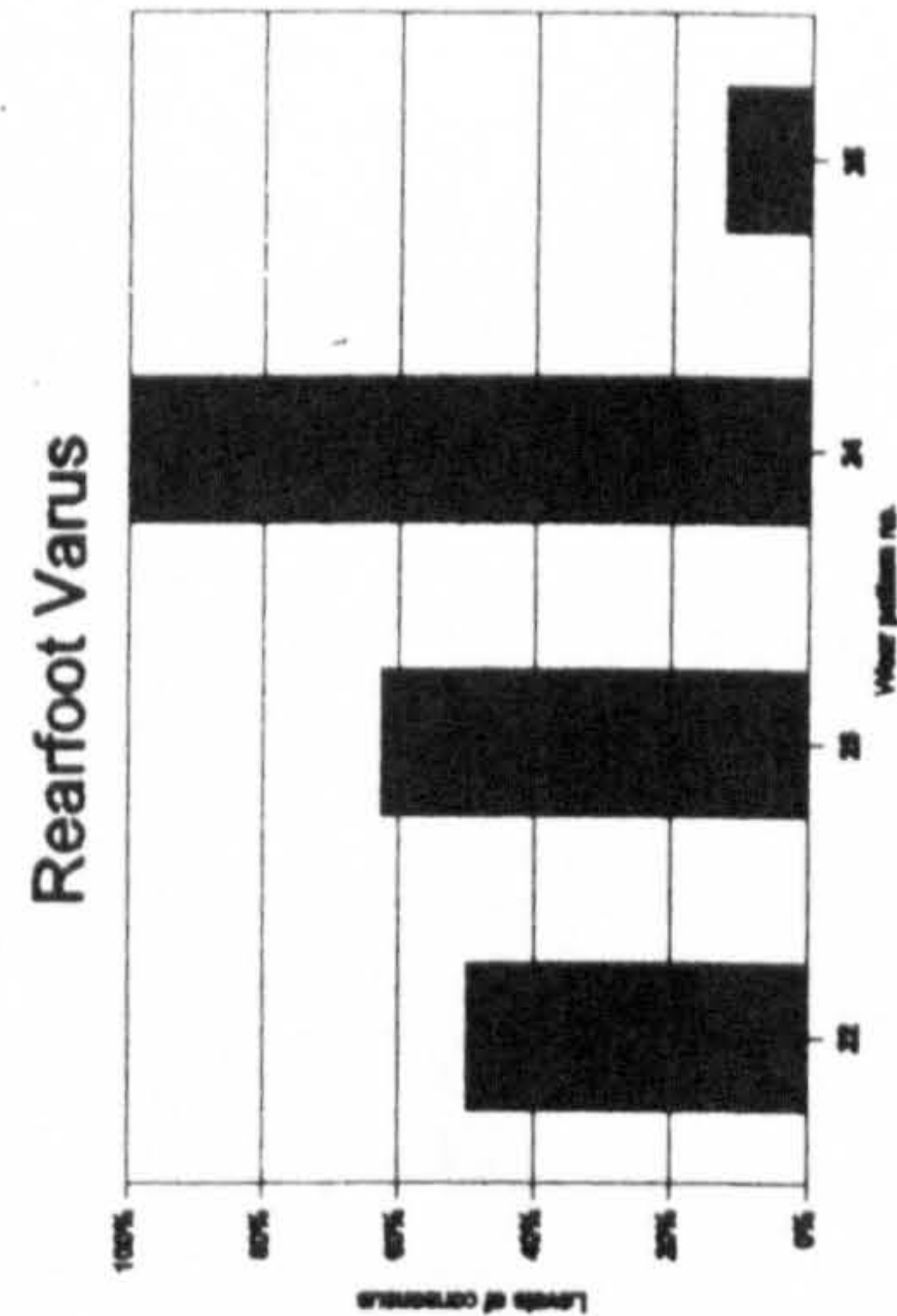
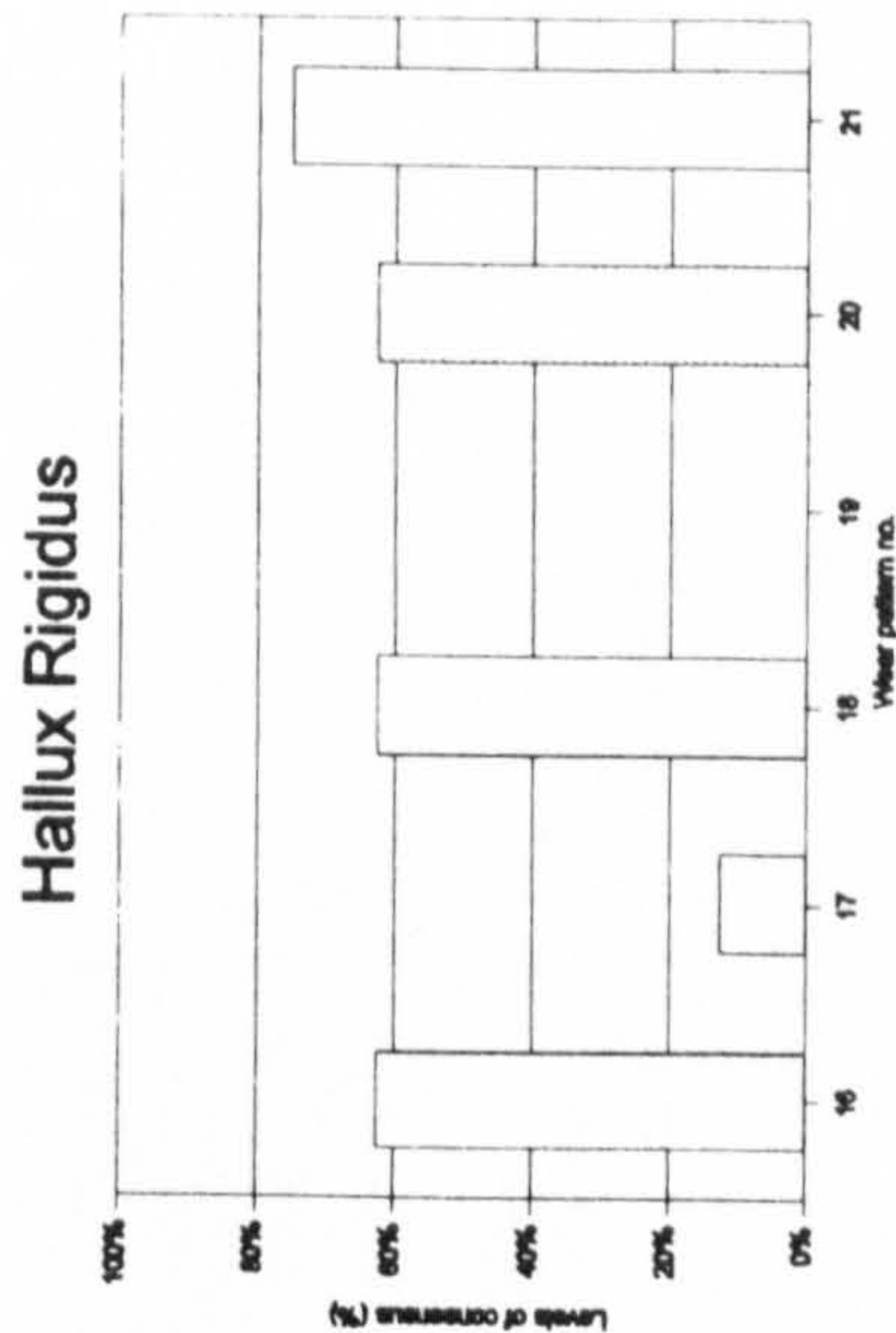
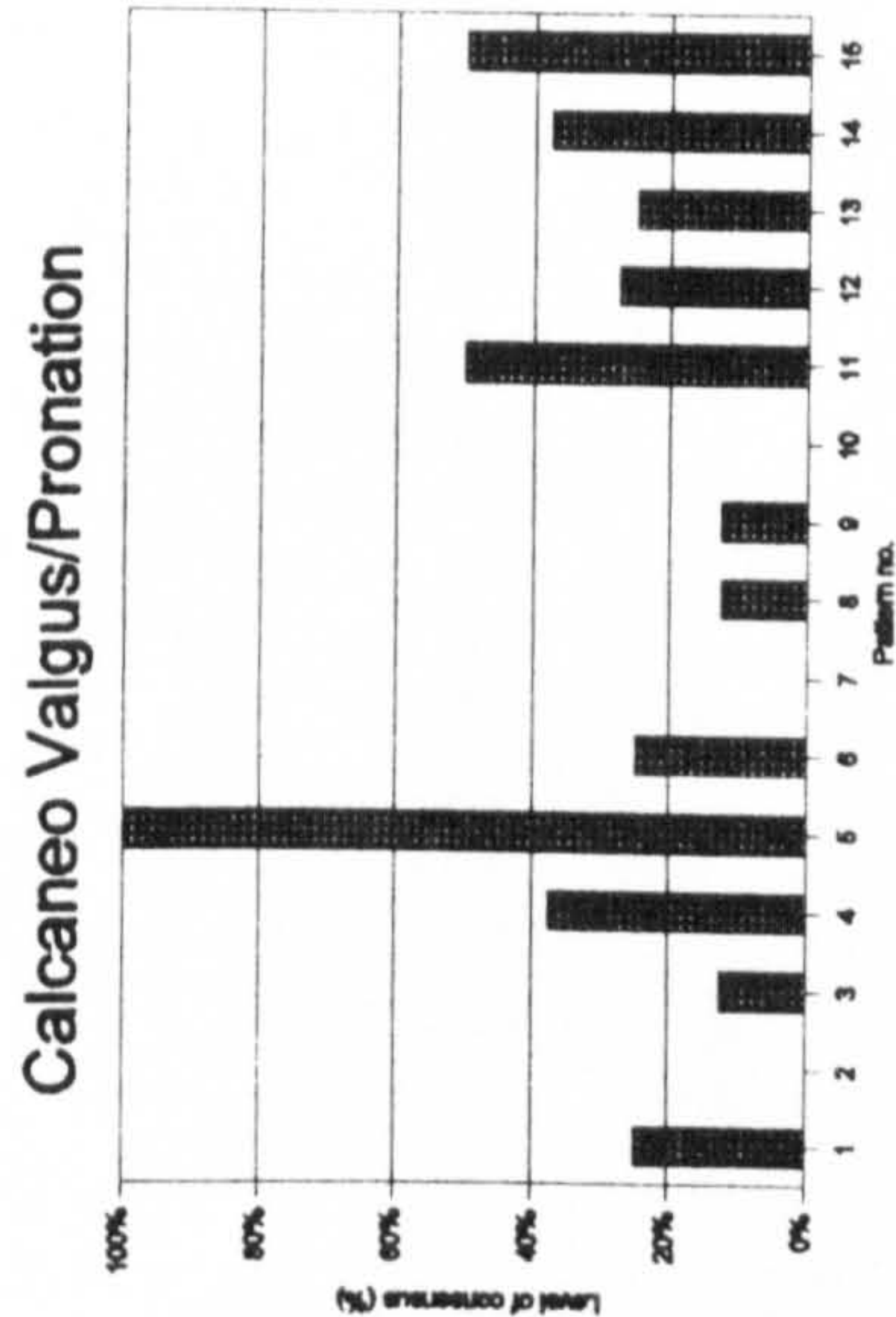


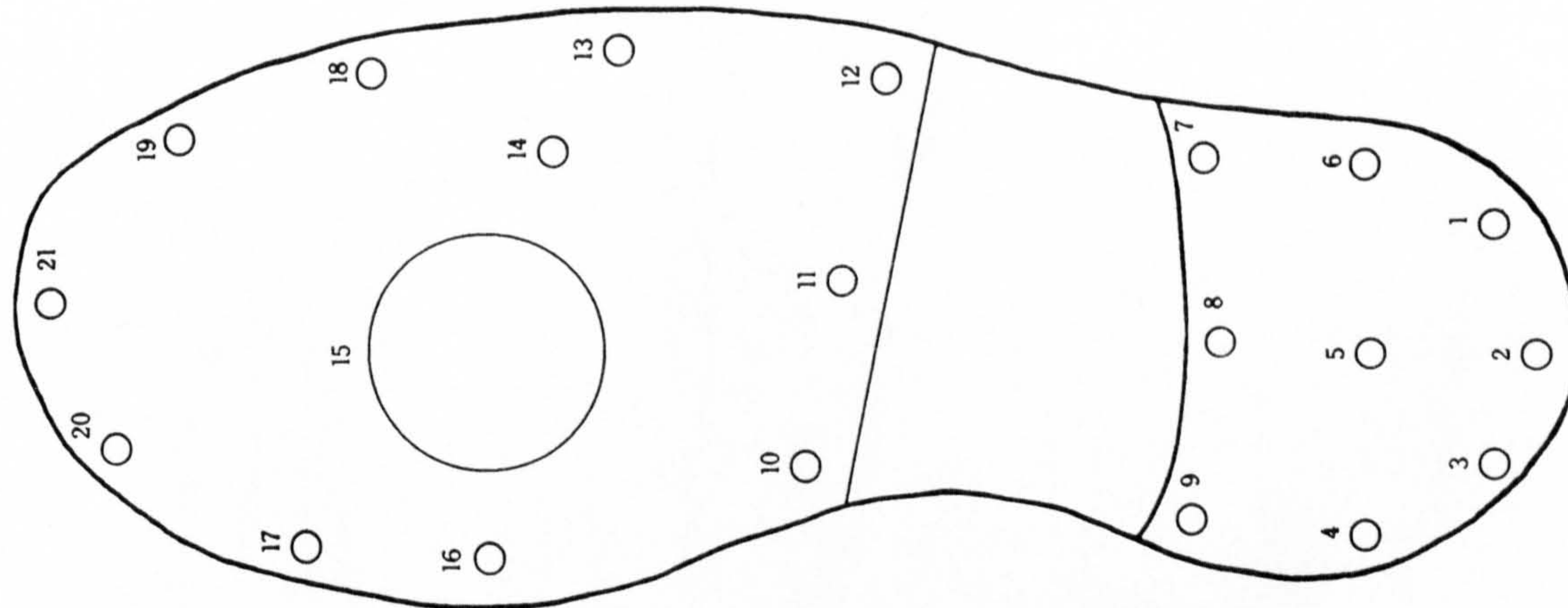
Table 2

Coded anatomical areas of the foot from which outsole wear would spread

Identifying code no.	Area of foot anatomy represented by code
1	Posterior Lateral Heel
2	Posterior Heel
3	Posterior Medial Heel
4	Medial Heel
5	Central Heel
6	Lateral Heel
7	Anterior Lateral Heel
8	Anterior Central Heel
9	Anterior Medial Heel
10	Anterior Inner Longitudinal Arch
11	Centre of foot
12	Base of 5th Metatarsal
13	5th Metatarso-phalangeal joint
14	4th Metatarso-phalangeal joint
15	2nd/3rd Metatarso-phalangeal joint
16	1st Metatarso-phalangeal joint
17	1st Toe
18	Tip of 5th Toe
19	Tip of 4th toe
20	Tip of 1st Toe
21	Tip of 2nd, 3rd and 4th Toes

Diagram 3

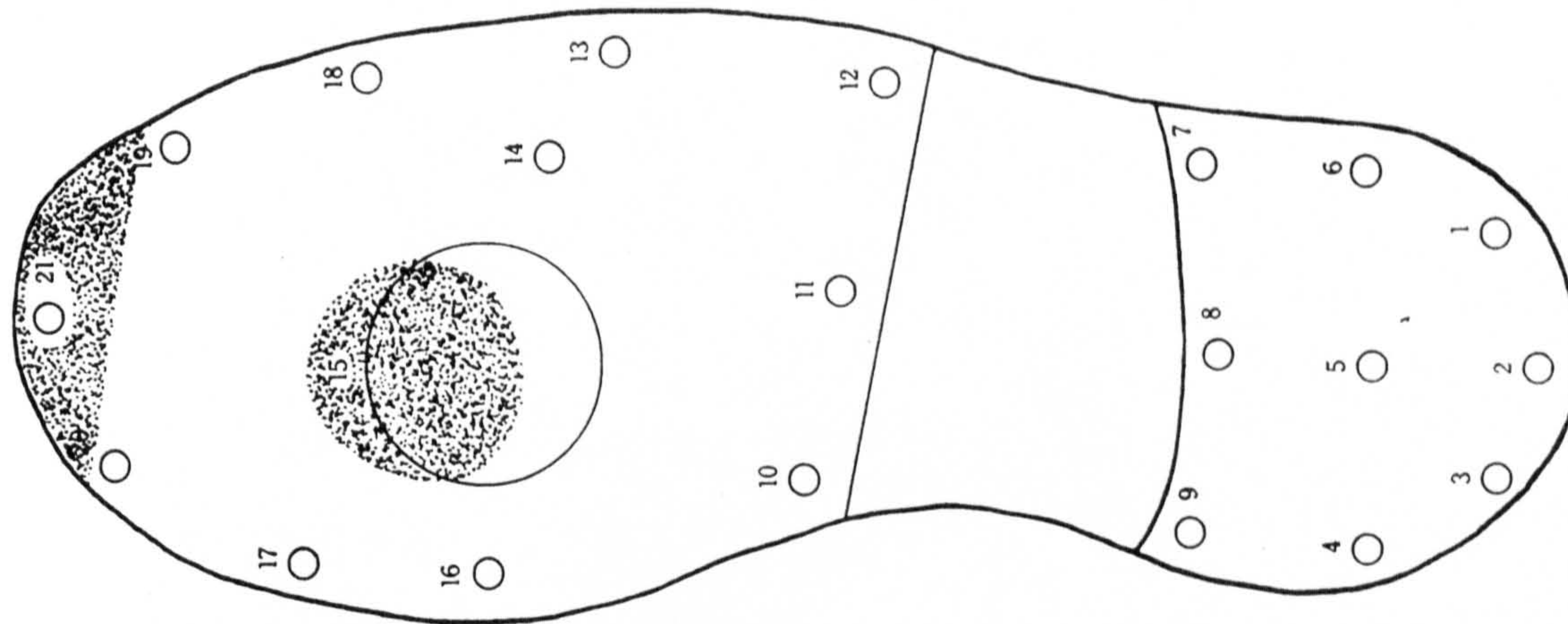
Draft instrumental grid for the interpretation of shoe wear marks



○ / ○ Equals central part of given Wear Area

Diagram 4

Application of the instrumental grid



○ / ○ Equals central part of given Wear Area

Table 3

Grid areas covered by Section 1 patterns

Pattern	Anatomical areas involved (with code)	Overall representative code
1	Posterior/lateral heel area (1.) 1st Metatarso-phalangeal Joint (16.) 1st toe (17.) Tip of 1st toe (20.)	1/16/17/20
2	Tip of 5th toe (18.) 1st toe (17.) 1st Metatarso-phalangeal joint (16.) 2nd/3rd Metatarso-phalangeal joint (15.) 4th Metatarso-phalangeal joint (14.) 5th Metatarso-phalangeal joint (13.) Posterior lateral heel area (1.)	1/13/14/15/16/17 18
3	1st toe (17.) 2nd/3rd Metatarso-phalangeal joint (15.) Posterior lateral heel area (1.)	1/15/17
4	Tip of 2nd, and 3rd toes (21.) Tip of 1st toe (20.) Tip of 4th toe (19.) Tip of 5th toe (18.) 5th Metatarso-phalangeal joint (13.) Posterior lateral heel area (1.)	1/13/18/19/20/21

Table 3 (continued)

Pattern	Anatomical areas involved (with code)	Overall representative code
5	Tip of 1st toe (20.) 2nd/3rd Metatarso-phalangeal joint (15.) 5th Metatarso-phalangeal joint (13.) Posterior lateral heel area (1.)	1/13/15/20
6	Tip of 4th toe (19.) Tip of 5th toe (18.) 5th Metatarso-phalangeal joint (13.) Lateral heel area (6.)	6/13/18/19
7	Tip of 2nd, and 3rd toes (21.) 2nd/3rd Metatarso-phalangeal joint (15.)	15/21
8	Tip of 1st toe (17.) 2nd/3rd Metatarso-phalangeal joint (15.) 4th Metatarso-phalangeal joint (14.) 5th Metatarso-phalangeal joint (13.) Posterior-lateral heel area (1.)	1/13/14/15/17

Table 3 (continued)

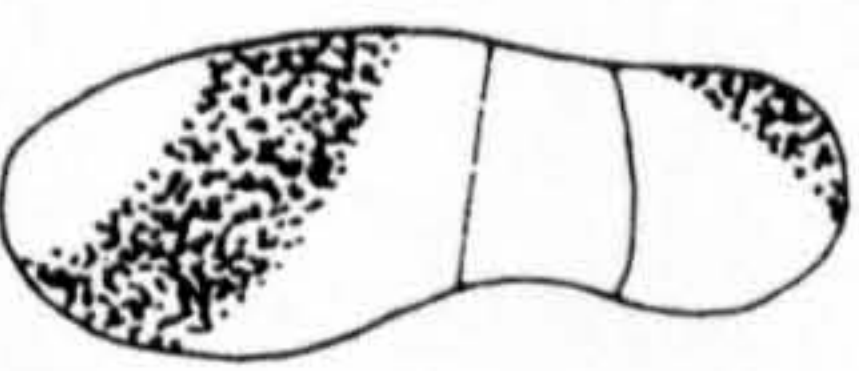

Pattern	Anatomical areas involved (with code)	Overall representative code
9	 <p>Tip of 1st toe (20.) 1st toe (17.) 2nd/3rd Metatarso-phalangeal joint (15.) 4th Metatarso-phalangeal joint (14.) 5th Metatarso-phalangeal joint (13.) Posterior-lateral heel area (1.)</p>	1/13/14/15/17/20
10	 <p>1st toe (17.) 1st Metatarso-phalangeal joint (16.) 2nd/3rd Metatarso-phalangeal joint (15.) Lateral heel area (6.)</p>	6/15/16/17

Table 4

Grid areas covered by Section 2 pattern components

Pattern component no.	Code		Pattern component no.	Code
1	20		14	1
2	17		15	1
3	16		16	20
4	16		17	19
5	16/17/20		18	13/14/15/ 17/20
6	13/14/15/ 16/17/18/ 19/20		19	16
7	13/14/15/ 16		20	13/14
8	15		21	1
9	9		22	16/17
10	7/8/9		23	13/18
11	4		24	6
12	3		25	1
13	2			

Section 2, the deeper hidden consensus with regard to these specific grid points became apparent.

Section 1

In using the instrumental grid to verify the level of hidden agreement in Section 1, it was noted that respondents had indicated that they believed some conditions to be responsible for causing a number of the patterns shown. As a number of grid points were repeated in these patterns, the grid points covered by that respondent were only counted once to avoid a bias favoring respondents who had given such multiple opinions (i.e., in effect, they were stating the same case several times). After taking account of this, it could be seen that a consensus of 70% or more had been achieved for several specific location points (graph 4).

Section 2

Section 2 had been devised to pursue hidden consensus for specific components of wear, but the true level of agreement only became apparent when the instrumental grid was applied to these components. As in Section 1 the same allowance was made for multiple code responses for single respondents and again, hidden levels of agreement represented a strong basis for consensus (graph 5).

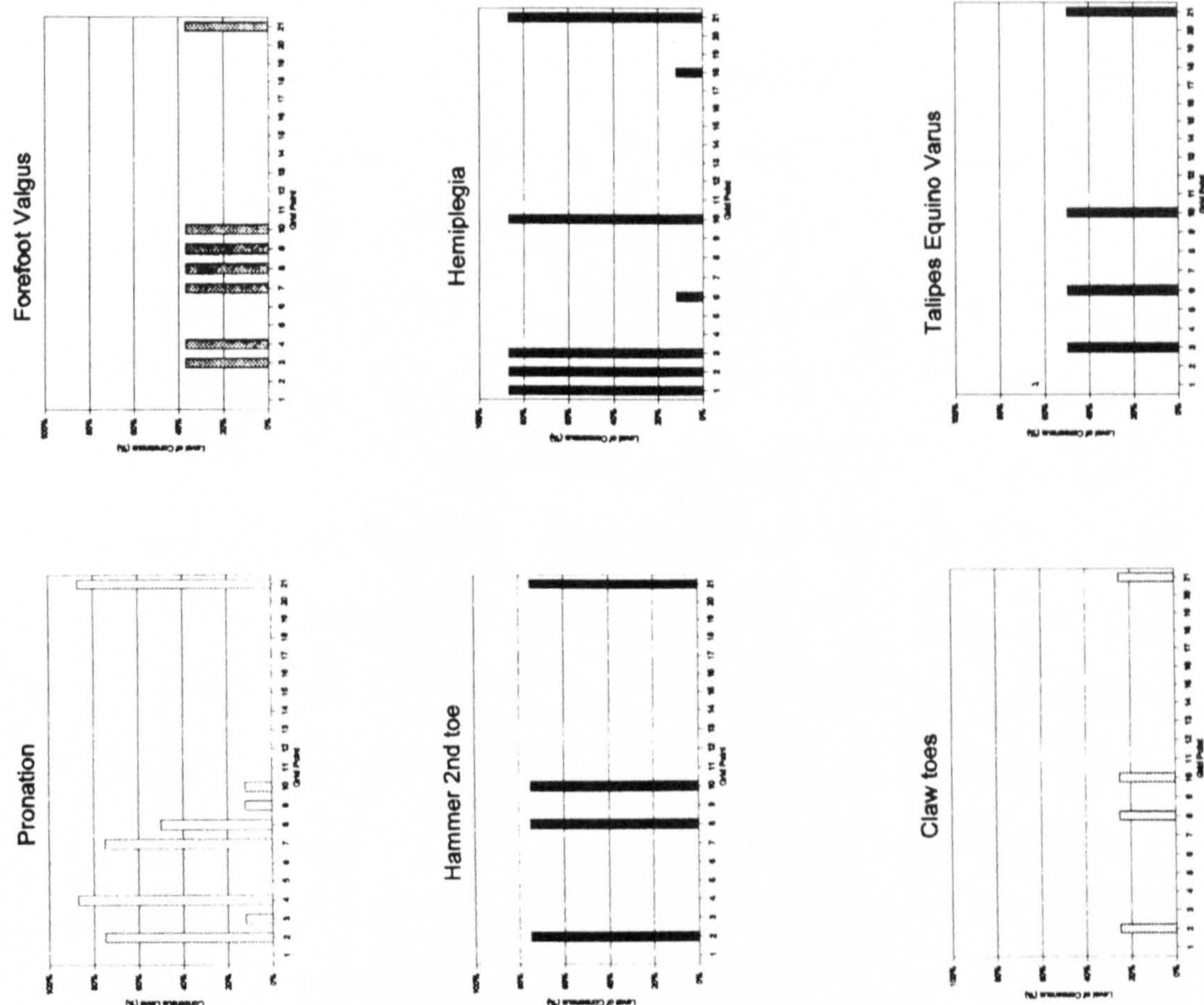
For Calcaneo Valgus/Pronation, the totality of patterns selected covered thirteen grid points. Of these thirteen points, 100% consensus had been achieved for three grid points (points 16, 17, 20). One grid point (point 1) had achieved 60% consensus and five grid points (points 9, 13, 14, 18, 19) had very low levels of agreement at 15%.

For Hallux Rigidus, the pattern components in total covered seven of the grid points. Of these seven grid points, 85% consensus had been achieved for four grid points (points 1, 13, 14, 20), two grid points (points 15, 17) had achieved 60% consensus and one grid point (point 19) had very low levels of agreement at 15%.

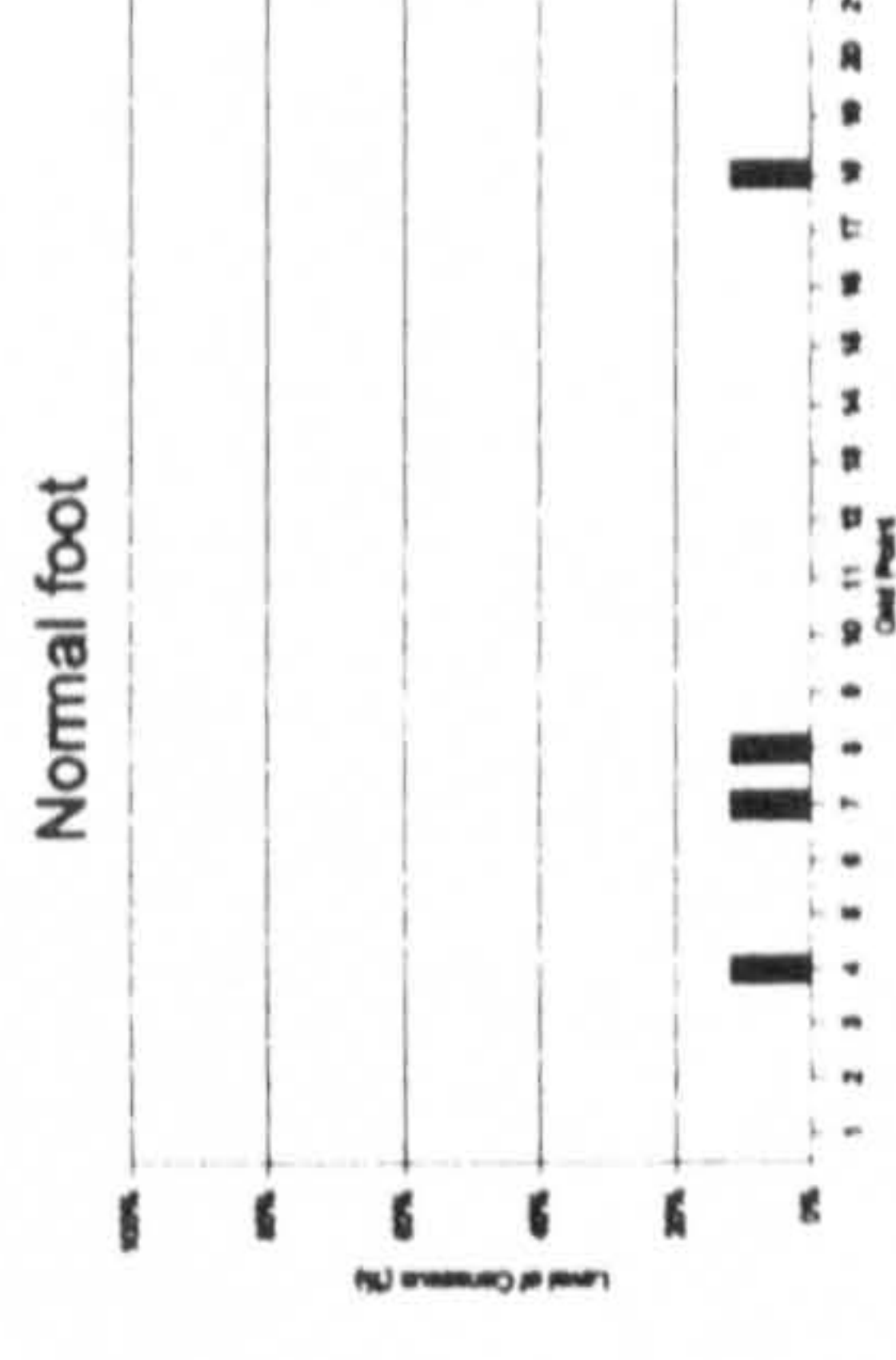
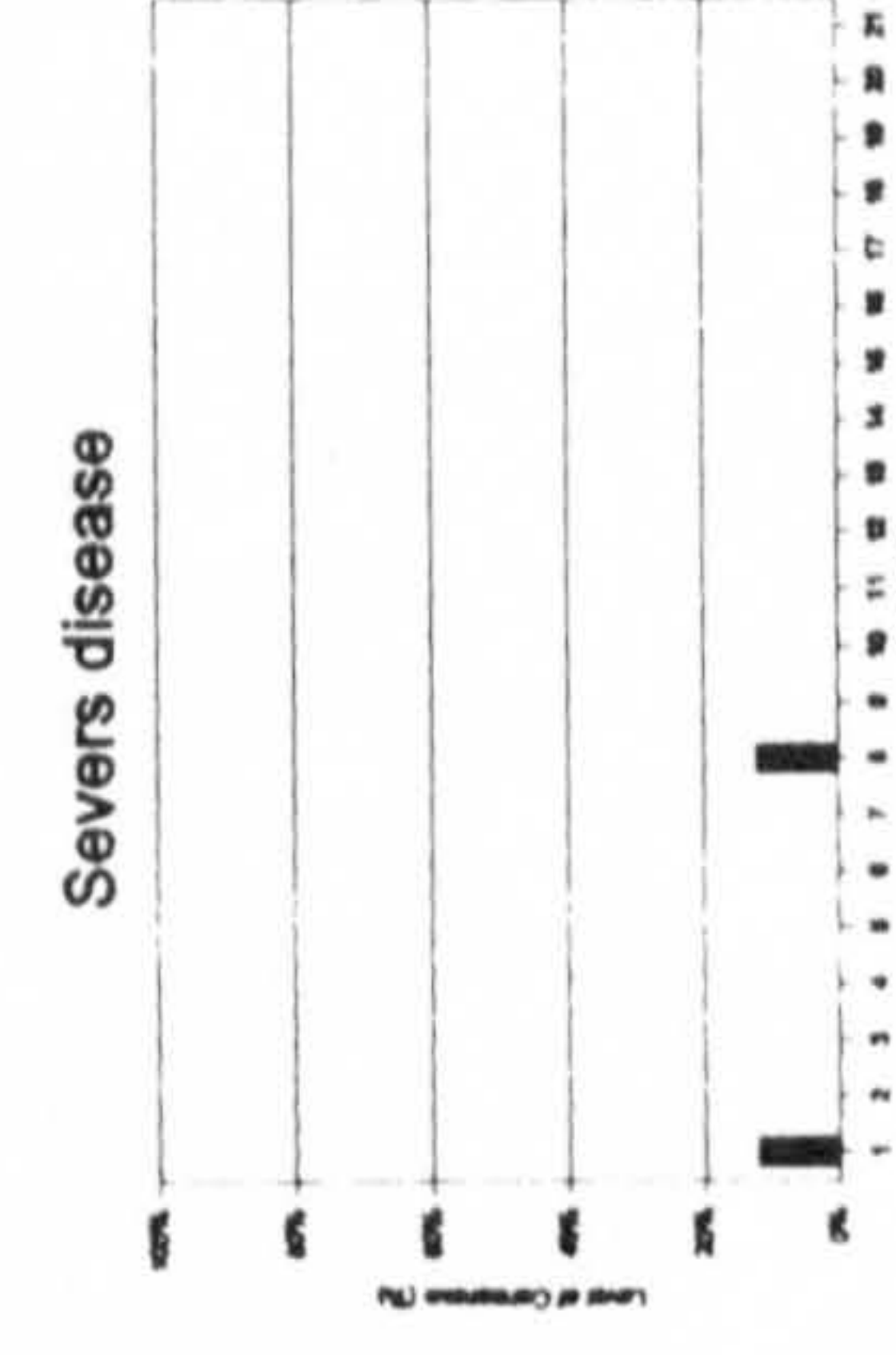
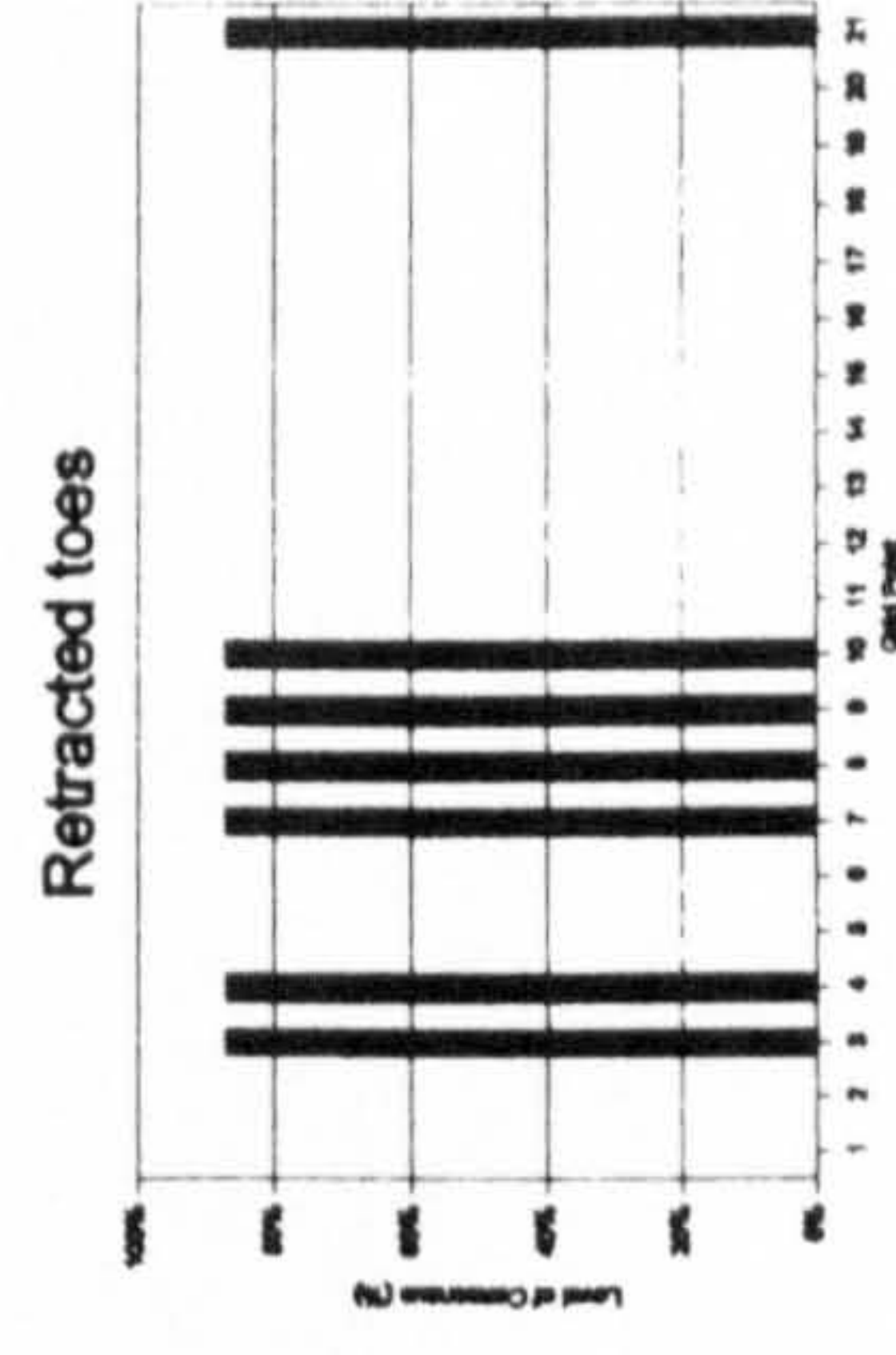
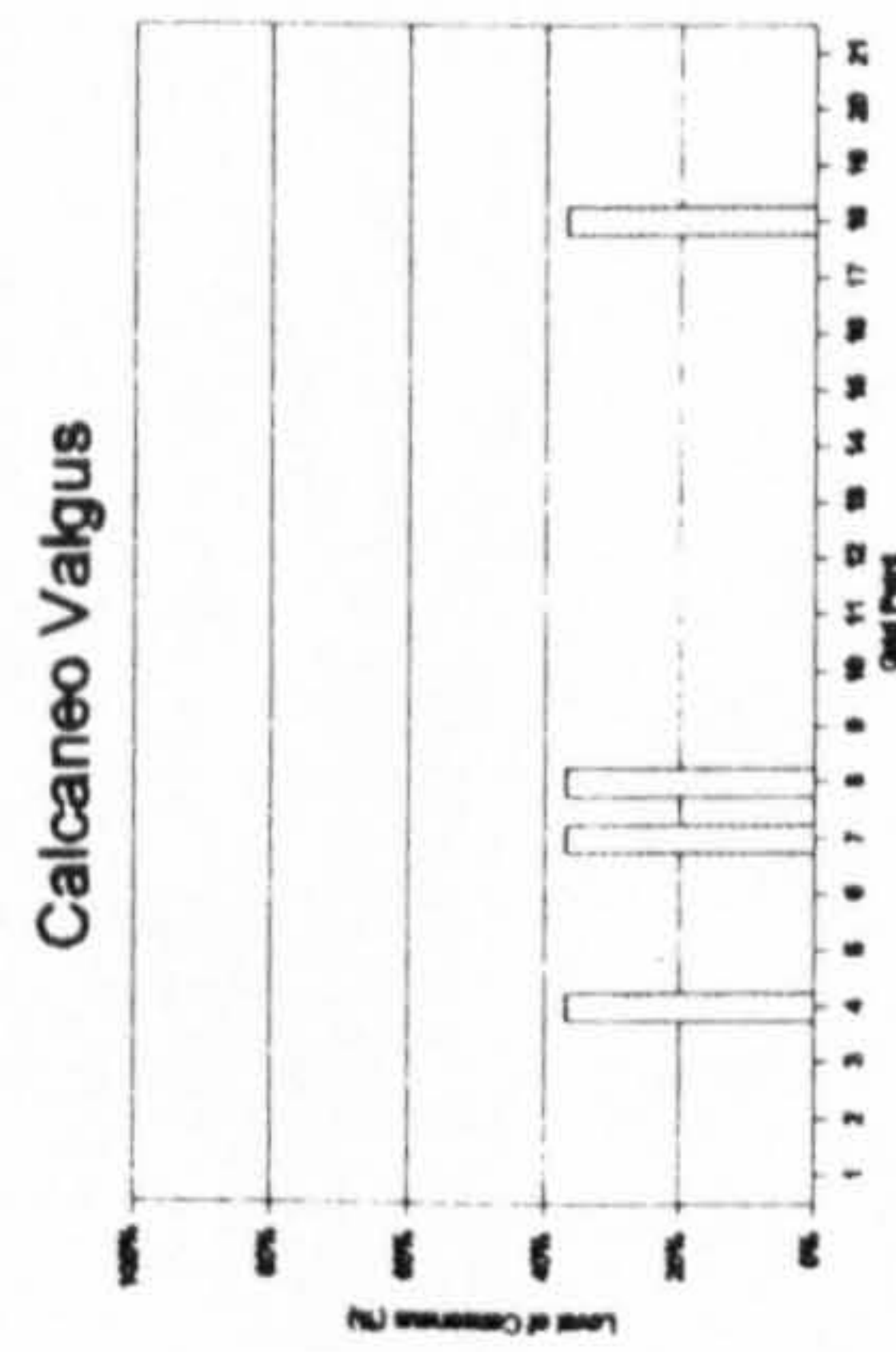
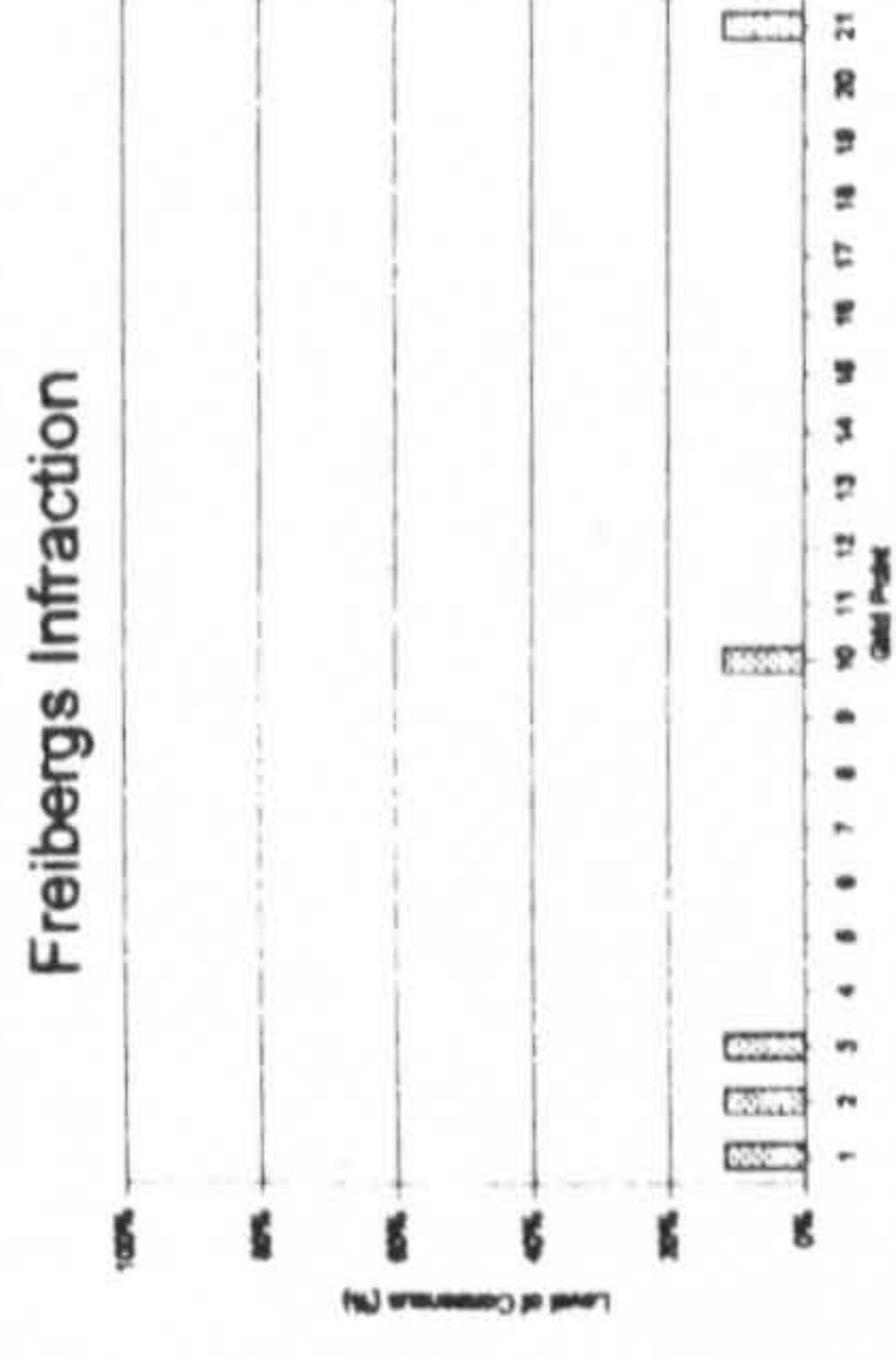
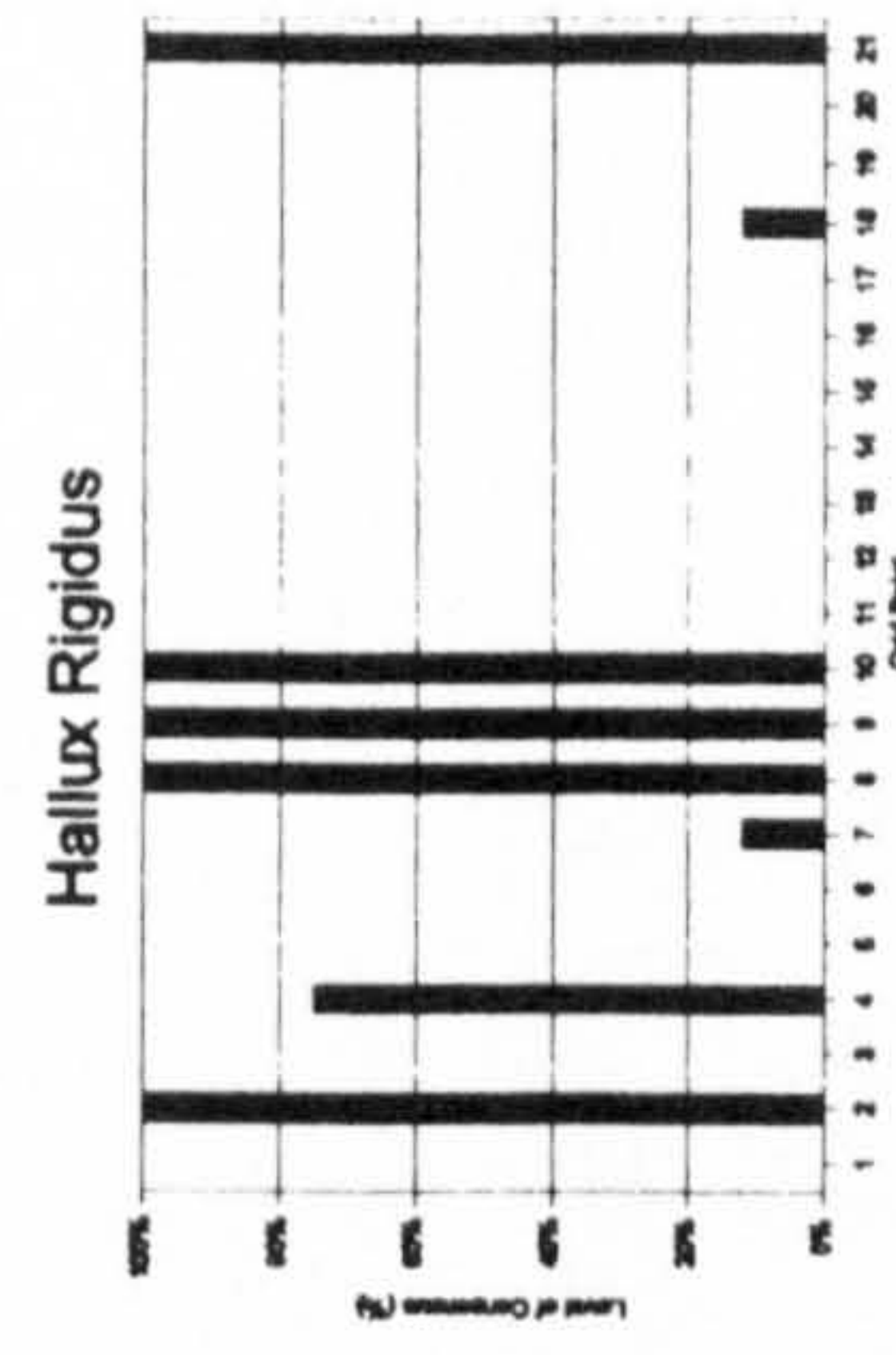
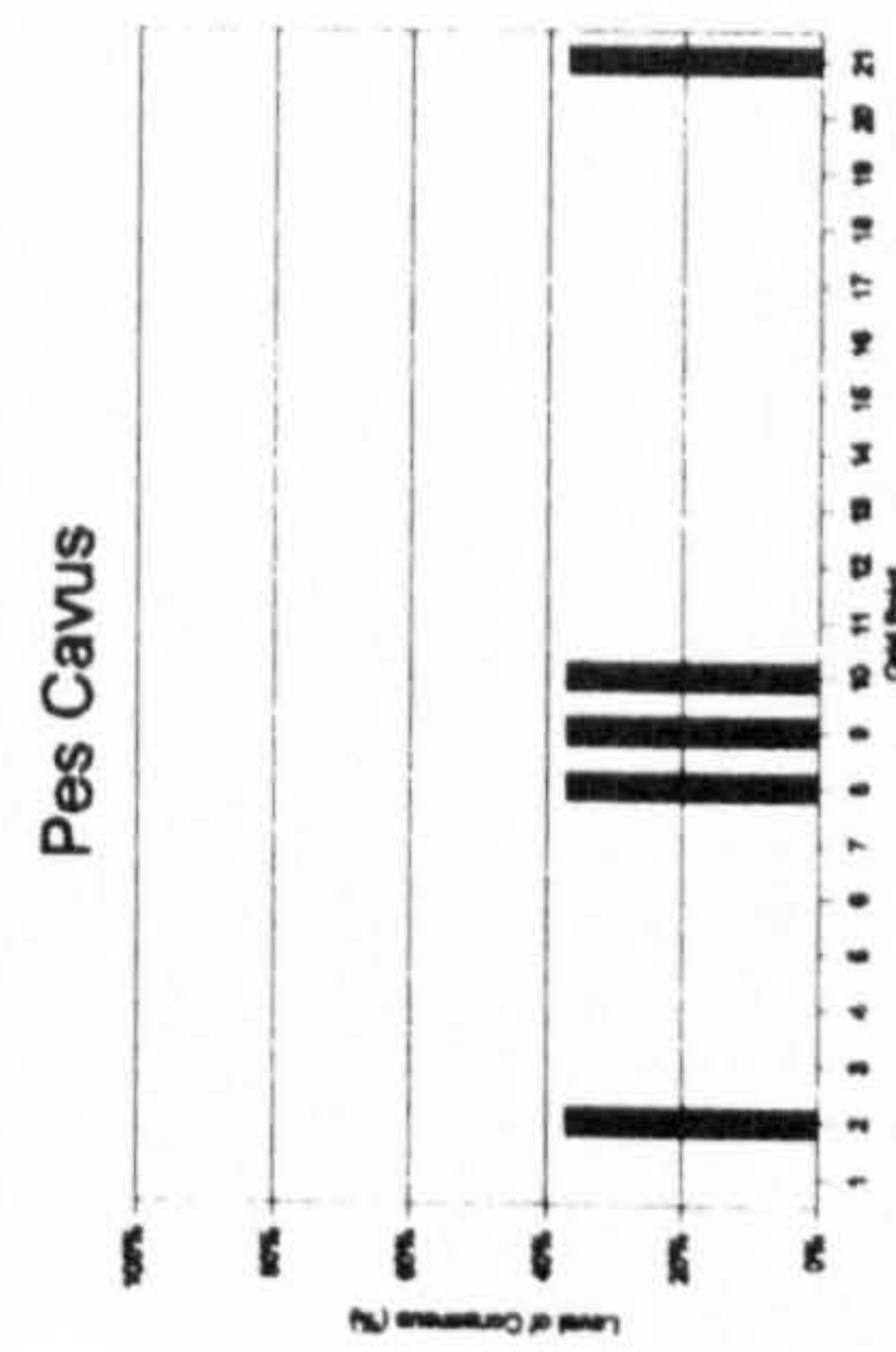
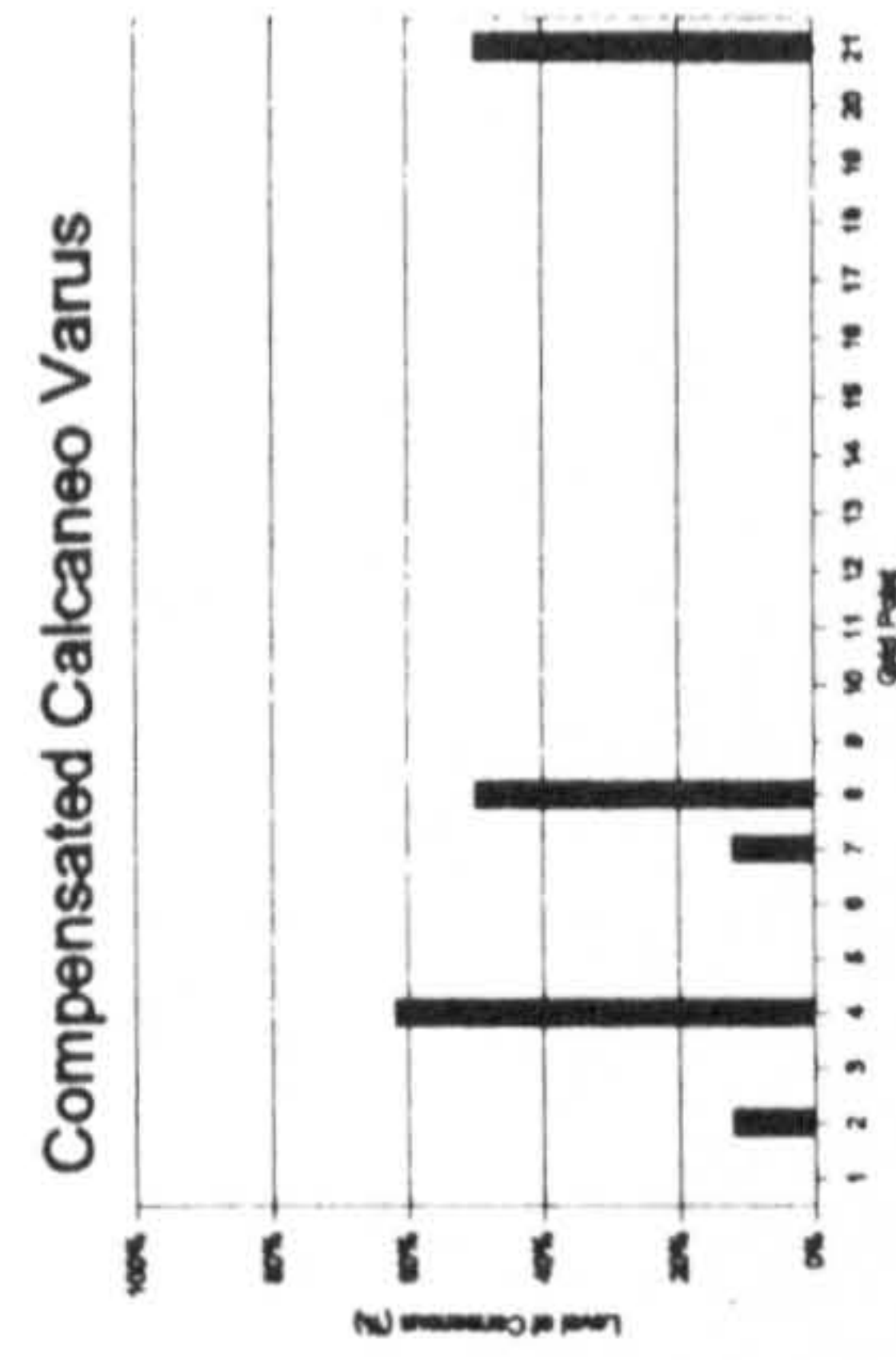
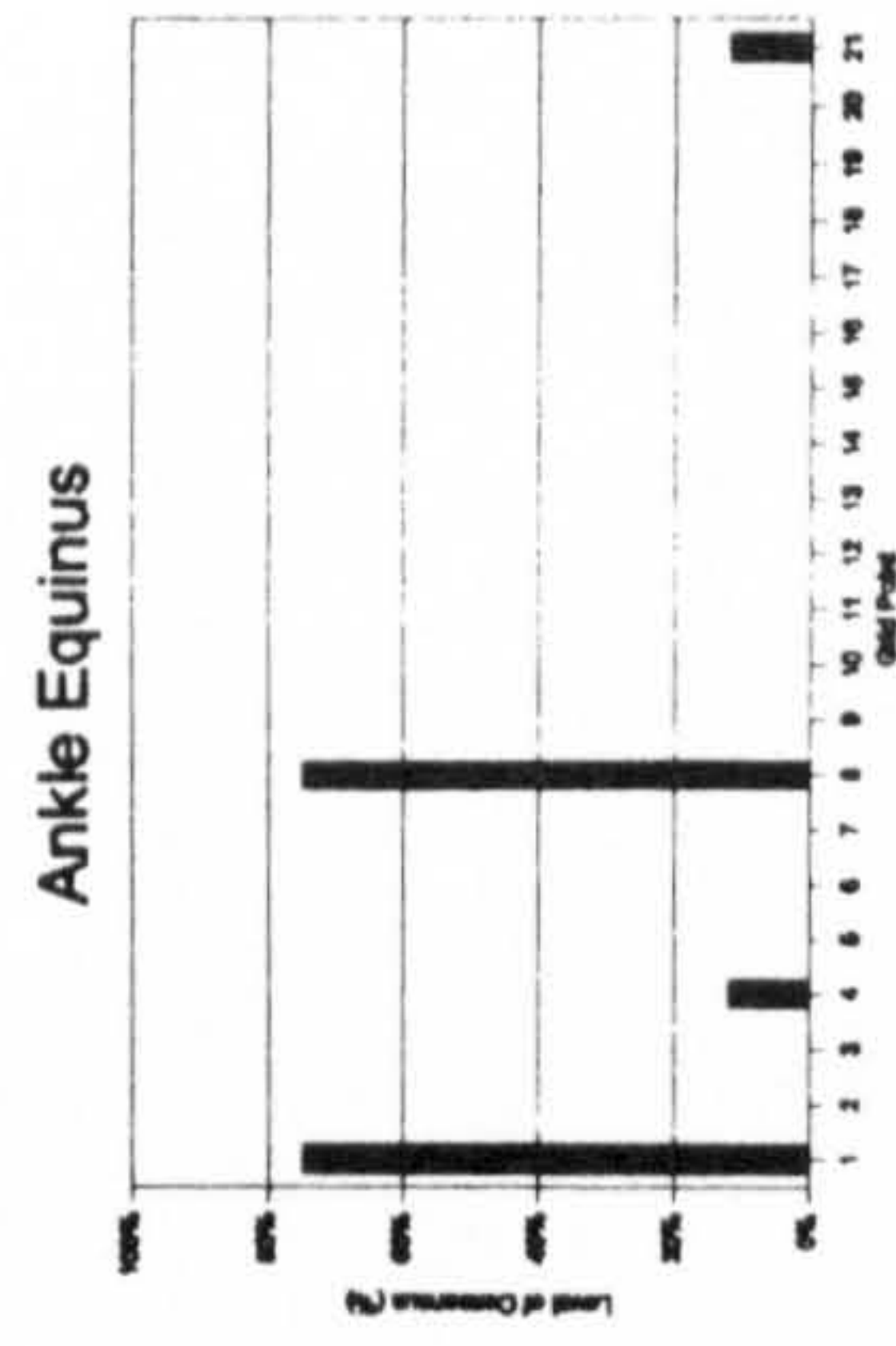
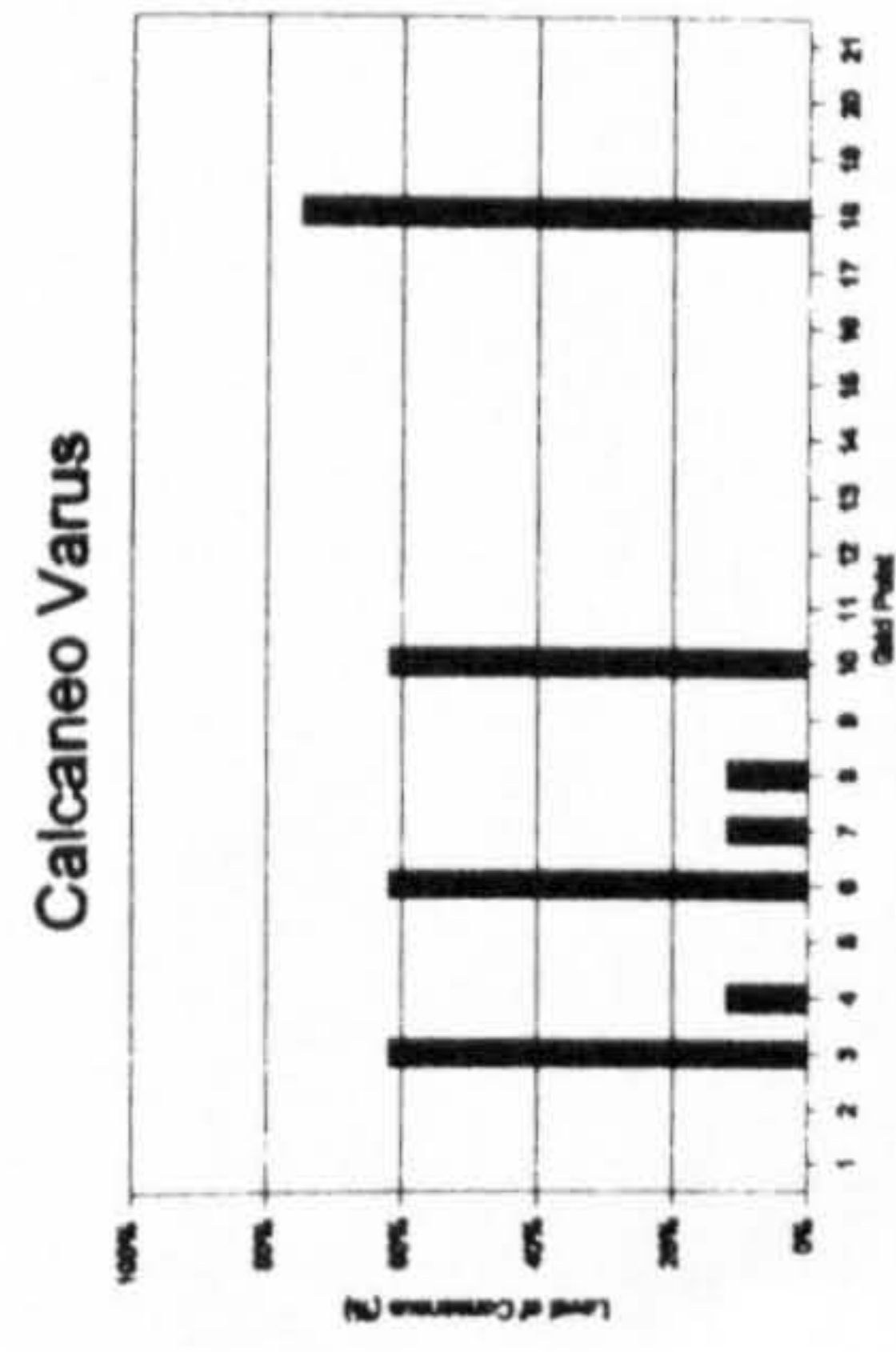
For Rearfoot Varus, the pattern components in total covered six of the grid points. Of these six grid points, 85% consensus was achieved on one grid point (point 6) and two grid points (points 13 and 18) had achieved 60% agreement.

Graph 4

Hidden levels of consensus in Section 1 by grid points

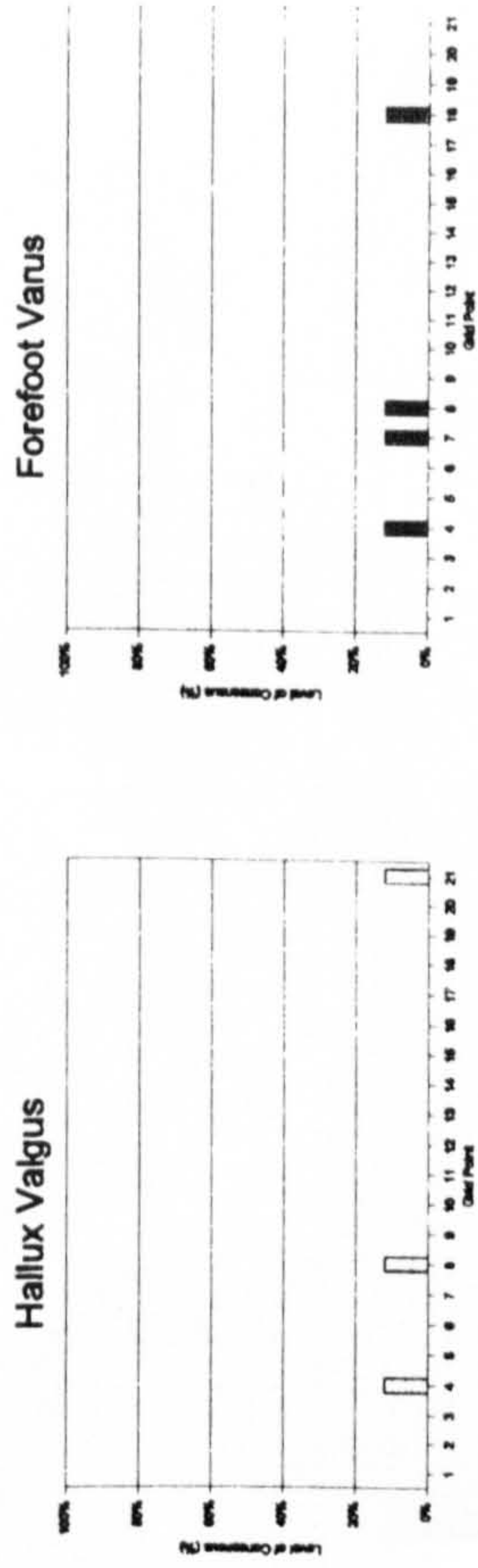


Graph 4 (continued)



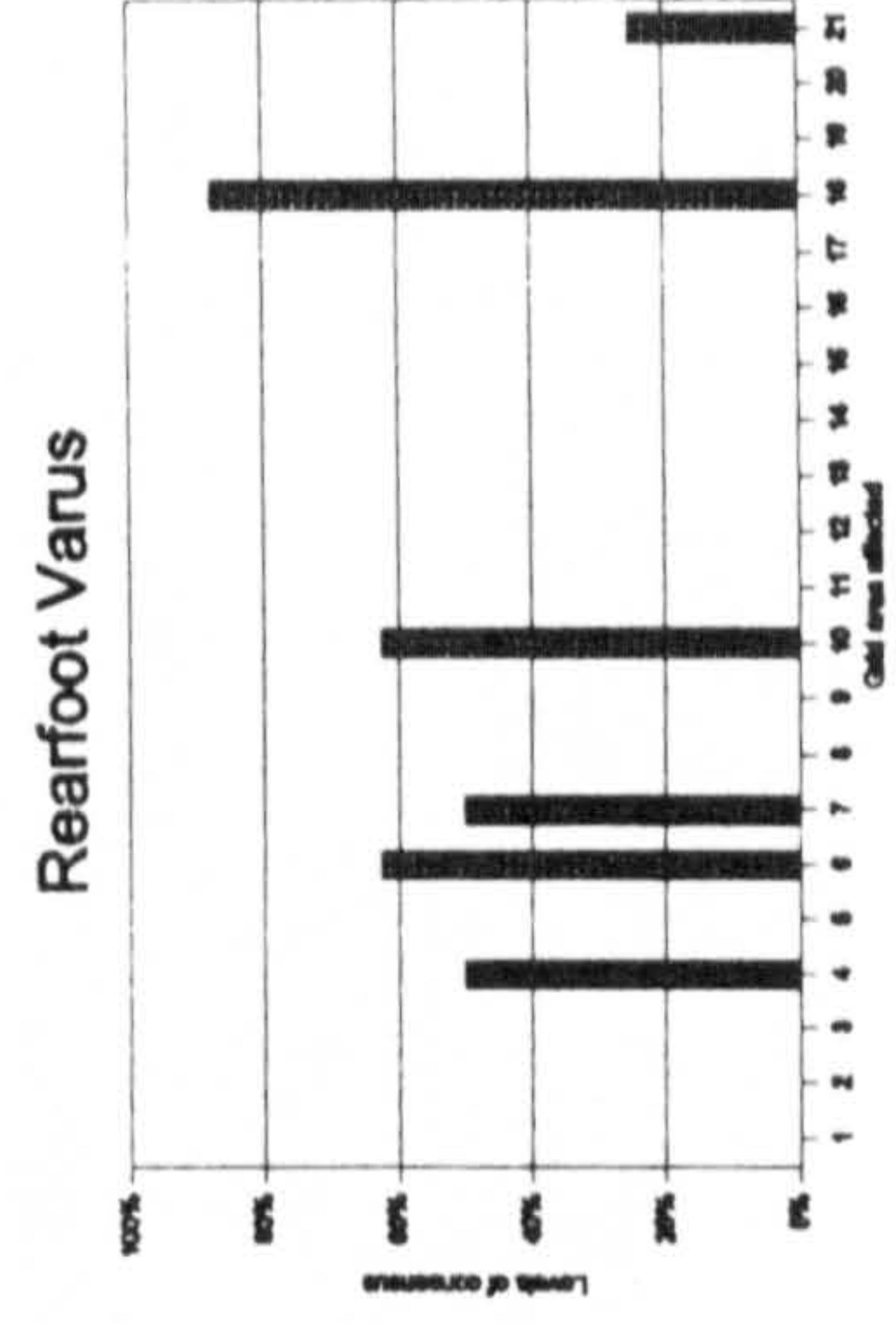
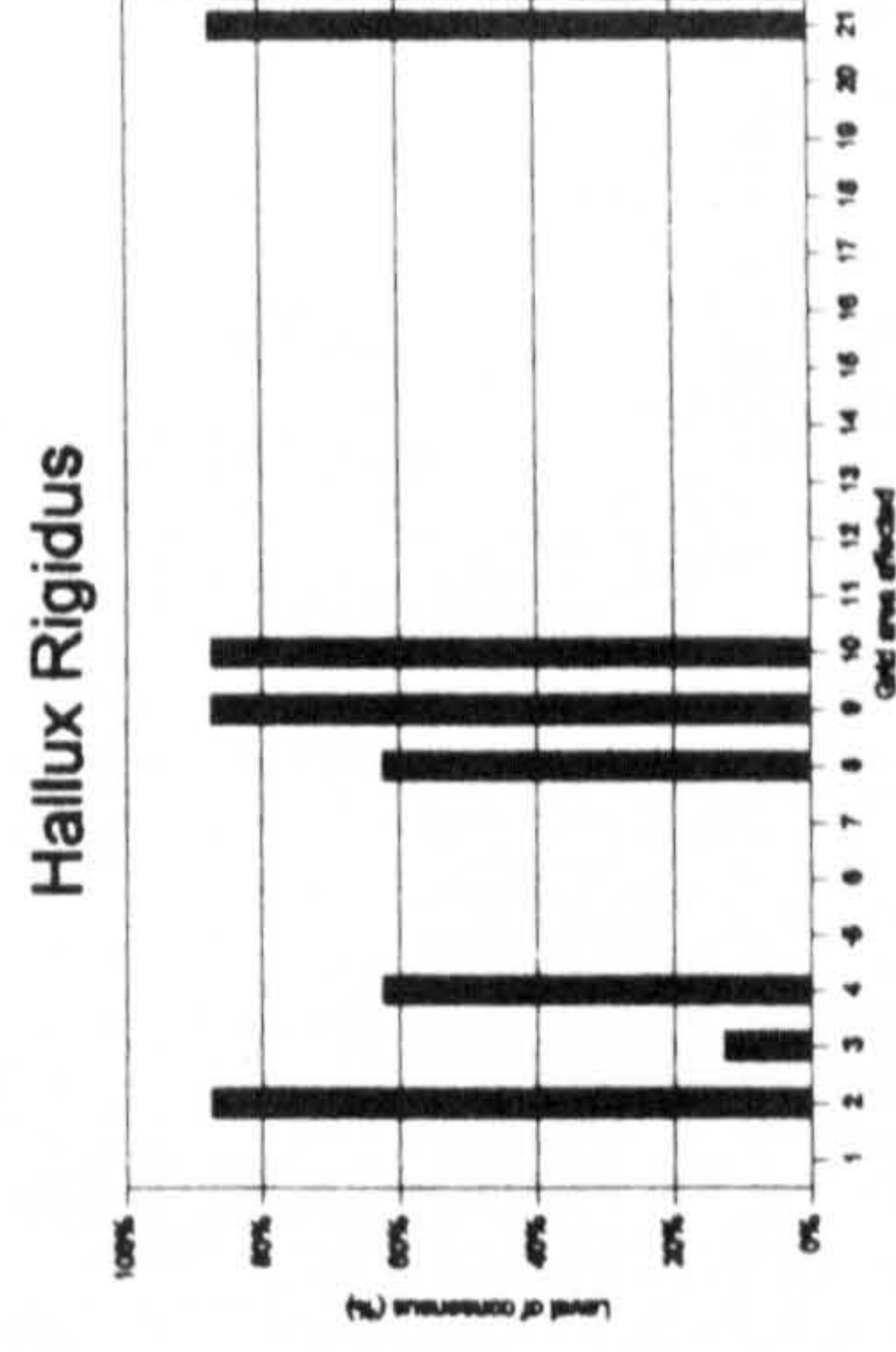
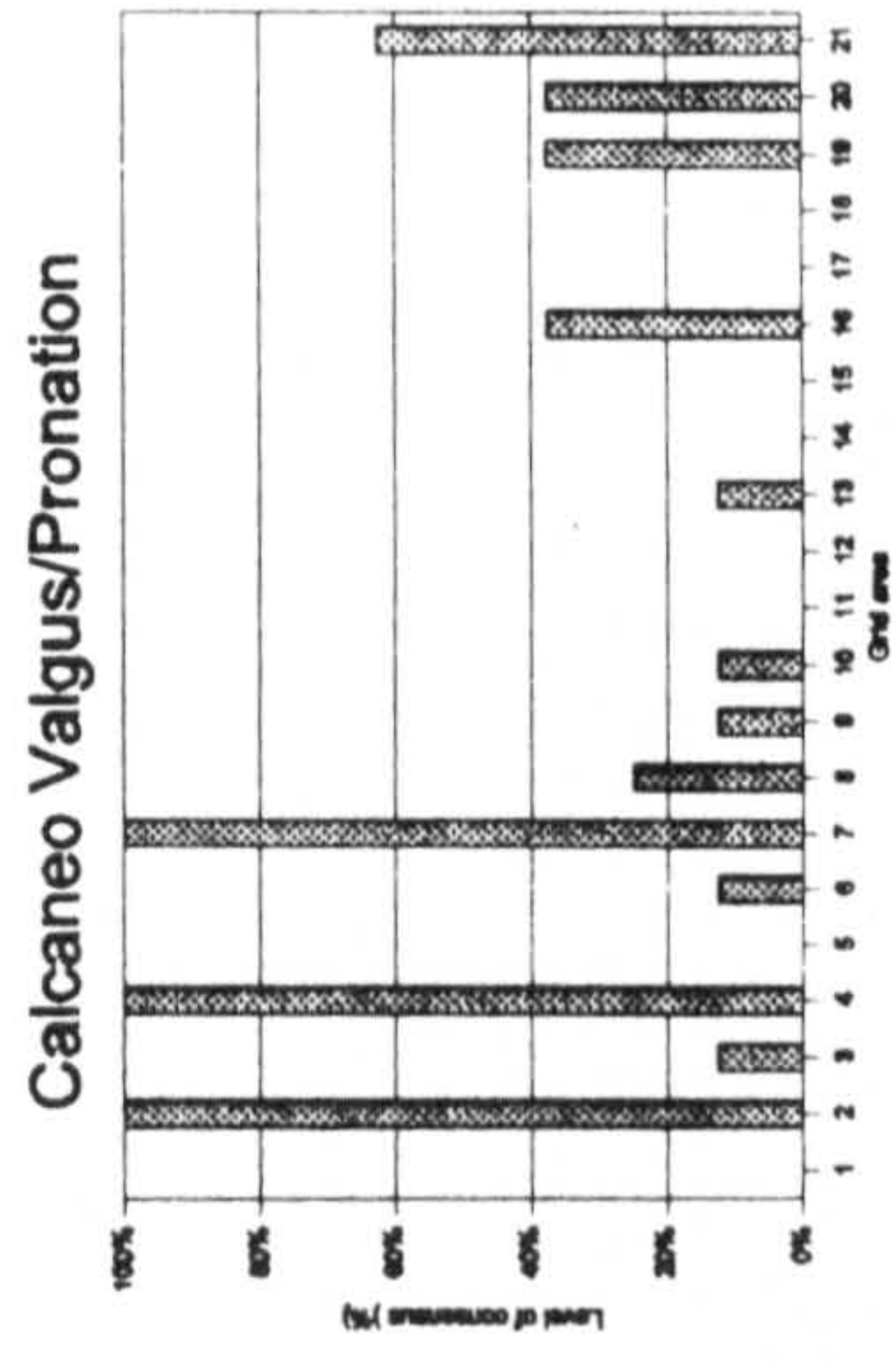
Graph 4 (continued)

Graph 4 (continued)



Graph 5

Hidden levels of consensus in Section 2 by grid points



Comparison of hidden consensus in Section 1 with Section 2

The three conditions being examined in Section 2 (Calcaneo Valgus/Pronation, Hallux Rigidus and Calcaneo Varus) also were chosen by respondents in Section 1 as being represented by some of the wear patterns shown. The hidden consensus in Section 1 was compared with that also observed in Section 2 for these conditions. Although the same respondents were involved in both sections, the context differed, so such a comparison would give an indication of the reliability of the responses. The consensual levels for the defined conditions in both sections compare closely. Graph 5 shows that the same specific grid points with strong and weak agreements occur in both Sections 1 and 2 and that these points differ between the three involved conditions. Only one grid point in Section 2 (point 17) had strong agreement yet had not been selected in Section 1.

Discussion

Although no categorical figure exists, a 70% level of agreement has been used in some Delphi studies [3, 4]. This level of consensus has therefore been achieved in recognition and interpretation of seven of the ten patterns shown in Section 1 and three of the twenty five pattern components shown in Section 2. This is a major shift from Round 1 where minimal consensus existed.

The higher level of consensus achieved in Section 1 over Round 1 of the Delphi study seems to demonstrate that when shown a characteristic pattern, podiatrists are capable of recognizing this and reaching high levels of agreement over interpretation. This is supported by the additional fact that nine alternative conditions not stated in Round 1 had been suggested for the same patterns presented again in Round 2.

This situation differs markedly from Round 1, when many different wear patterns had been suggested as being characteristic for a common condition. It appears that when asked to reproduce a characteristic wear pattern from memory alone, podiatrists have difficulty; however, when shown a pattern and asked for an interpretation, this is an easier task, especially when a limited list of possibilities is also available. Recall from memory has proved difficult, yet when faced with an image, memory recognition occurs. Similarly, most people have no difficulty in facial recognition, yet have considerable difficulty in reproducing the face by drawing from memory. This phenomena is well known and understood by psychologists and is explained by the differ-

ence between recall and recognition memories in a visual memory context [5]. The consensual failure observed in Round 1 [1] may therefore be due to memory failure alone.

Although a swing towards consensus had been observed with regard to gross patterns, there were still areas of disagreement between participants. Subsequent Delphi rounds should either confirm or remove these opinion differences when respondents would be asked to give an explanation in support of such differences.

Delphi Round 2 moved towards consensus at two levels. The gross picture (i.e., that of fully depicted wear) has moved towards agreement but differences of opinion are still present. The instrumental grid using focal points for comparison, however, demonstrates a hidden basis for agreement and in Section 2, the apparently low levels of consensus are seen to dramatically increase when the grid is applied. The focal points represent areas of the outsole which relate to the functioning of the foot during its contact with the ground and from which the wear spreads. This is a potentially useful and novel manner of looking at wear marks.

Concern has been expressed by forensic scientists over the number of variables involved in outsole wear. Both variability in shoe wear belonging to the same individual and similarity of wear in shoes belonging to different individuals has been noted, thus limiting the value of outsole wear in identification [6]. It has also been stated that the number of factors influencing wear characteristics is also small [6]. Using focal points of wear as the basis of a measurement grid would address these concerns. Where shoe variables exist (e.g., age of shoe, sole material, shoe style, etc.), these variabilities could be eliminated by focal point assessment – the focal point remaining the same irrespective of the amount of wear and peripheral pattern shape.

Focal grid points would only record the fundamental effects of causative foot/gait conditions which would remain irrespective of the spread and peripheral variability of wear. They would therefore be giving information about the condition present which led to the wear and not about the individual specifically. If, however, the individual has an unusual causative condition, the probability of a link with that individual would be increased. The availability of 21 grid points also increases the number of wear characteristic factors available for consideration and the high number of possible selections of grid points could in some cases provide the powerful individuality required in

forensic science. Common conditions would exhibit a bias towards a greater frequency of occurrence thus limiting the value, but conversely, more unusual conditions of foot functioning may reflect a high level of individuality.

Round 2 analysis of grid point consensus shows that combinations of grid point codes for each condition appear to differ. The method of recording shoe wear by focal point code as represented by the measurement grid may therefore be useful in identification after further investigation through subsequent Delphi rounds and validation at all levels.

Conclusions

This 2nd Delphi Round has moved towards a basis for consensus at two levels. At an obvious level, there is a moderate consensus basis reflecting the difference between the recall memory utilized in Round 1 and the recognition memory required in this Round 2. When examined on a grid point basis, a stronger hidden consensus is observed relating specific combinations of points to named conditions.

Although involving the same participants, results in Section 1 correlated closely with Section 2 results indicating that repeatability should be expected. This focal point basis is a potentially useful method of looking at wear marks and if 100% consensus opinion can be achieved in subsequent rounds, this could form the basis for an analytical measurement grid. Using focal points of wear, variables relating to materials, style and age of footwear would be eliminated as the focal point would remain the same irrespective of wear amount.

A follow-up Delphi Round 3 is now required for all patterns/pattern components that have not yet achieved either 0% or 100% consensus. In this next round, respondents should indicate with which patterns they are in strong disagreement and also mark focal points of wear on the depicted patterns in addition to justifying the maintenance of a minority viewpoint. If the higher levels of consensus sought can be achieved, then the concept of an evaluative interpretation grid would gain greater strength and testing and validation of the grid would follow.

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