t a ., 1999, 2001; A b a t t a ., 2002; B a t, 2001; B a t a S , 2002; K t a ., 1994, 1998).

H , b t t a c a a c a c , t c a a' t f t t c f t c t a t b c a b t a' act at t c a a t c ' c c t a a a c . H c a c a c a t f t t c t a c t f t t a t c a t b t a a c t a (c t) . I t t a t , a ' - t a t f c t f t (c - c) c t a t' f t a f a - t a a (A b a t t a ., 2002; B a t, 2001; B a t a S , 2002; D a c t a ., 2003; F - ' a t a ., 1999, 2001; K t a ., 1994, 1998).

It c t, , t a t a t c t b - t f t t t' f a . T t c a ', f c a t a c a t a - c a t c t t a a '- c a t a c t c - t , t a ' c t a t c t b t t t t' f a c t t c t b - t f f a t a a . R c t ', F ' a t a . (1999) a a t a a c t b' - t a t t a f a t a t a c c t t a t a a a c t b a t a ' a a t a t t a f a t a t a t 't (b).

1.2. s g e e e a a s a a a e g a e e a a a s g e e e

It a b c t t a t a t a ' a a t t c f a a t ' a f a c f a - t c t f t a (f a Z , 1993). F a , a a t f a a c a t t a t a , t f t c t a , c a - t f a a c a t f t a , a t a t a t f t a f t a - a a t t a t (A b - a t t a ., 2002; D b t a ., 2002; D ', 1983; F ' a t a ., 1999; G f a t a ., 1988). T ' c a a a t c a t a - t - a t (SNR). F a f t a t t t t t a t a t t f t, t SNR t f t a b c a t a a t f t a t f t a . I a t , t a t t t a t t a a t a' f t a t f t a t f t a t a t t c t a b t' (B t a P , 1988; Z , 1993). W b t t a t a a a c a ' c a ' a a t , t a f a a c b t t a c t c c (a a c t a b a a t a c t) c a t b' t ' c a a a t c c t' f b t c - t a ' a t t t a t f t a a b - t t c a a t c c f t a . H c , t x c t t a a t a t a a - t c t t a c t a t a .

F ' a t a . (1999) a t t c t f t a - a a b a a c f a - a b' t c c c t t a a t t c c a t f t a t a a (b). I f t a f a c b' a c c a t a t a t f a c t a f a a , t c a t t a t f a t a a c c f t f .

I a b a t t, t t ' - c t c t a f t f a c b t a t - a' c t f t c . I f t t a' b t t a a f t c t a a a c f t c t a a c t' t (1 10 , t a t f t t), t t' c a ' c a "f " a f t c c a t a t a t f t c . T a b a ' a t c c c t (Wa a c t a ., 1949; f B a t, 1997; L a Y , 2002; L t ' t a ., 1999; Z , 1980). I t a b a t ', c c f - f c t t' c a ' a t b' t t a t - t a t a ' a a t a . D a' t a t f a f t a a t t t a t c t a c c a t a t a a a a a c - t f t a t c c f t c t f t a - a . B' a c a a t t , c a t c t c a c a t f t . F ' a t a . (1999) t c c c t t c a c a a t f a f t a t a a t . I t f t x t a c t (FR FR a FR RF c t), b t a f t a - a a a a t a a (t t) b t a t t t (t c) a a t (t c c c t). F t a t t c , t f t a a a - a' t t a b' 4 . T t - c a f t a t t c t b f t f t a a . F t a t , t f t a a t a b t t a b' 4 . T t c a a a t t f t a a t t a . I t , t c a c a f t t a t a t a c b a a t a t a t a t a' a a t , t t a a t t a t t ' c a ' b t - a . F ' a t a . f a a a a t a (4 9 B) f t c a t a a a t t c t f t c b' a f a t a a t t c b' a - t f a t a , b t a c a a a t a (t a 1 B) t a t c -

ct . B ca t ac t c at ac a t c a b ta t a ' t a tc t c cat f t a (F ' a t a., 1999 f a c f t), t a a a ta f c at a a at a t a t c ab ' cat t c .

1.3. g a a a a s g a a e e s e e

I t t a , att t t cat a a F ' a t a.' (1999) t Ma a- a C t . C f t t a a a t . T at , , t tt t at a a ab t t a a a a ta f c at a a at f c t f C c , t t tt c - a f f at a a at b' c a act t c f t a a c t f at t . I t a at a t t a t - ct t at t t t f t a f f at a a t c at a a at a' b t E a Ma a C . F t, t c t at t att a t t f t c a b ta t a ' t E a C - . S c , t b t att t a at f Ma - a C a' at t f a f f at a a t c at a a at .

T t ct f a C ' ab ca b t t t c t : a t a c a t (' a a b f ' ab a t a c a t), f b' , c t f b' a c a t . C a t E , C ' ab a c c a t a f c c - a t . V c c a t a a ' a t a c c a t b ca t ' a ' . T a t ca c t a c f - a C c a t t a E . I t , C ' ab t b ab t t c a . It a b t t att t - b t' f C c c ab ' t a t at f E c c t f a - (Ka , 1998).

O t t a , E a a a , t t c c t f t c. F a , c a t t c t ' ab " a" f at, t , t a fa , t fa , c a t a f t . T t t b - t ct att f f at a a f C c . W Ma a t a att t a ta - t Ma a ta , t ' a t t t c c t t at ta ' t c ct ' t f' a t f t . B ca tc c t f at c, c a tc c t a ' t tat act t' t a a (-a t ') at a' It b t att t t c t a f f at a a t t' f f at a c f b t t ta t a c a . T , t a t f a c ac a a .

I t t t ', t c c ct t c c at a a at f ta t C t c f t f at a - t c a . I a t , a t at f t f t a f c f a t t c cat f t a a t a t at t t c cat f t ta t.

2. Materials and methods

2.1. a a s

T ' t' t (a a = 21.1 ' a) t a a ba a c (t a 15 B c b t t a) a t , c - b' a t ', a t c at t t '. T t a a a Ma a C .

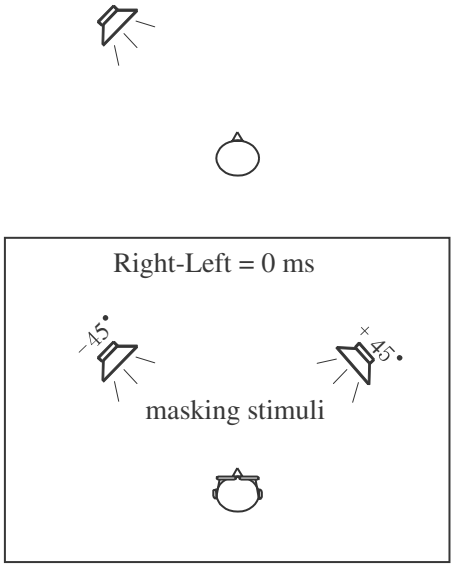
2.2. a a sa a e a s

Pa t c a t at a c a att t c t f a -att at c a b , c a 192 c t , 181 c t , a 196 c t (EMI S A t c E a at Ac t c S t). A ac t c a t att t a at f 22.05 H t 24-b t C at E t ' b a t (t a b t- a t a a t) a a t - f t a (C t), t c t f a c t t a P t IV c . T a a t t f t a (C at I 4.1), c t f ta a t a a att f t a t t 45° t ' t ca t ct t t a a . T a t a a at ' a f a at t t a a b ' t, a t ta c f ac f t t a - t t c t f t a t c a t ' a a 1.5 . Ta t c t C " " - t c b' a ' f a ta , t a t CW (Ta A). T ct E t a at f t t c a a b t t t ca t t E t c t at b' H f (1997) a a t b' F ' a t a. (1999, 2001). T t c a ' t act ca ' c ct b t t a f . I ac f t ta t t c , f a , "O a c at c t c a ", t a t ' (a cat b' t a) t at a c c c t t t . N t t at t t c f a

t a ’ t t a t f c t f ’ . T t c c ta ’ t a c t , a at 22.05 H a a a 16-b t PCM a . T ta a f a a c t t f a t fact c a a / a c t at ac t f t t c . T t c a b- t a ’ t 24 t f 13 t c .

Ta t t c t b’ t t t a t f t a t t t a a t f t a b’ . T a t c a t c t ta- t t c a a c f t t .

T t t’ f a t : a c . T bta a ct a - tat f ’ f a C ta , 5000 c a f 10 ’ f a C ta (20 26 ’ , 500 f ac ta) Mat ab f t a at t a at f 22.05 H t 16 b t a t at . T t 0.66- a a t c t ’ at (t t a a b t - t) t a t a f C c ct . F . 1 t -t a a ct f



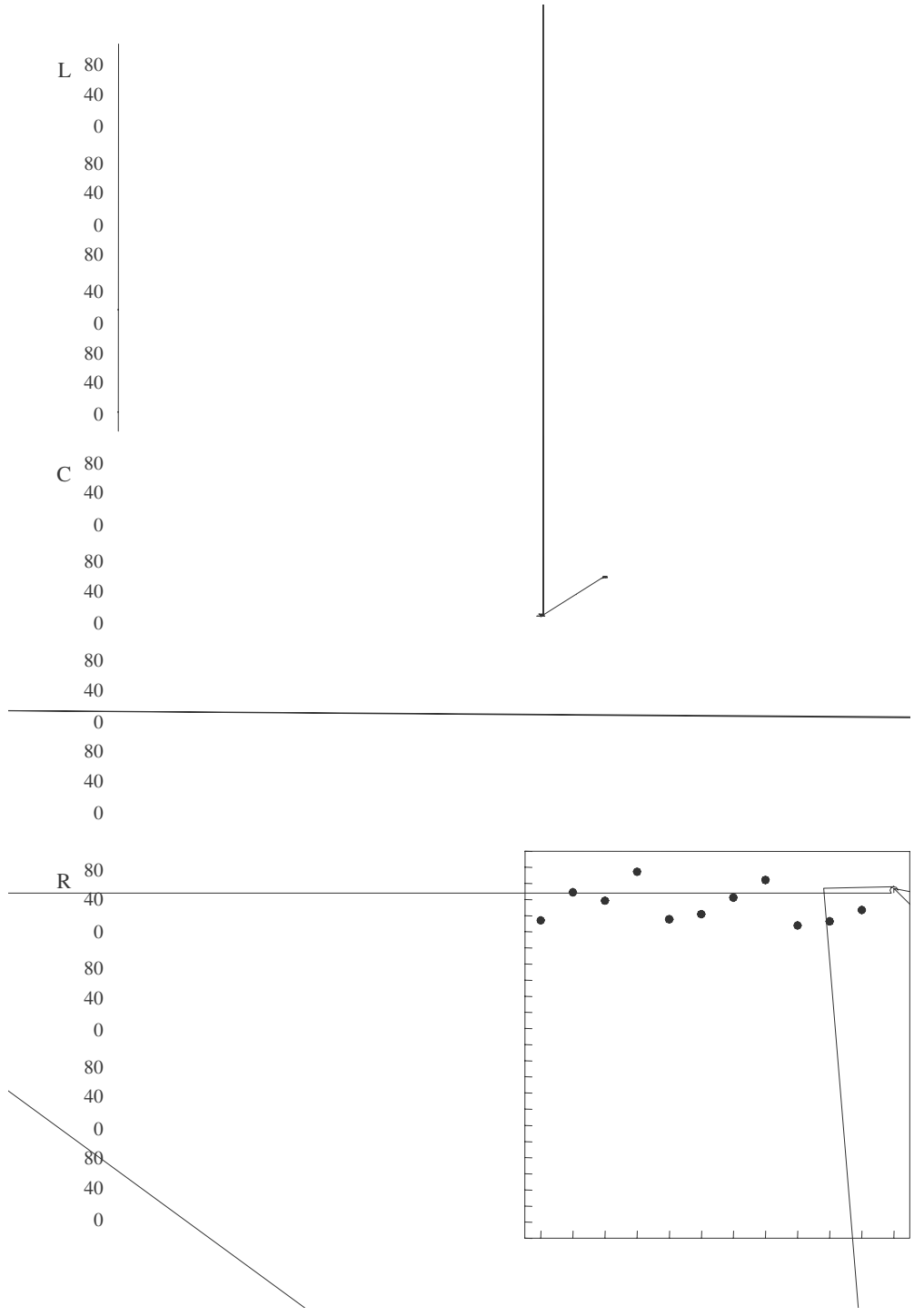
a t t ac a ' ata, t L b Ma a t t (W f a , 1991), t bab t' f c ct t cat f ' , *x* t SNR c t , μ t SNR c - t 50% c ct t cat (t t at), a σ t t f t ' t c f ct . F . 3 c t-c ct t cat a a f ct f SNR f ac f t 12 b ct t f - a c t : (1) a - c ft (NL); (2) a c c t a ' (NC); (3) a c t (NR); (4) c a c ft (SL); (5) c a c c t a ' (SC); (6) c a c t (SR). I a , t ' t c f ct a t t a ata.

T ' t c f ct F . 3 t t a t (t SNR c t 50% c ct t cat) ac a t c a t . M a t f t t c t a F . 4. F b t a c a , t t c cat f t a f t at f t ta t (NL a NC NR f t a , a SL a SC SR f t c a), cat a c at a cat ct f b t a c a . H - , t ct a c a f c a t a t a f a . I a t , t a a c t at f t a at a ca- t a t ta t (NR a SR), t f t a c a ab t t a . T att f t a c b' 2 (Ma) b' 3 (P c L cat) t - a t c a t ANOVA c a a ca t a ct f Ma , (1,11) = 13.719, MSE = 2.359, = 0.003, a ca t a ct f P - c L cat , (2,22) = 21.984, MSE = 1.801, < 0.001, a a ca t t act b t Ma a P c L cat , (2,22) = 3.503, MSE = 2.794, = 0.048. T t t c f t t act f- f ct c ct a at ANOVA f t a c a .

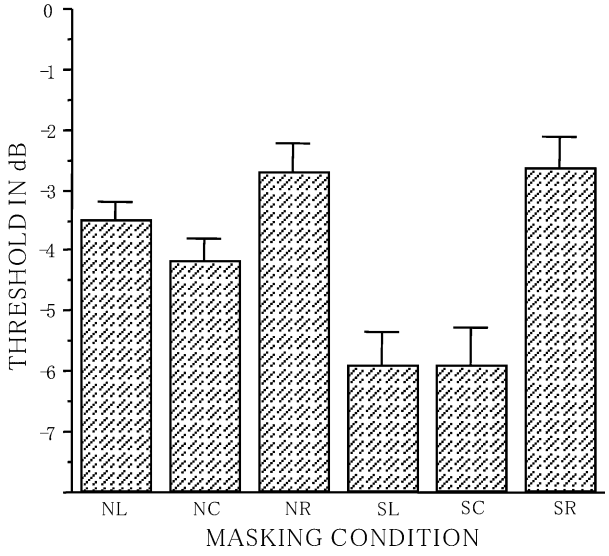
F t a , t cat ct t a t t ca t, (2,22) = 3.430, MSE = 1.898, = 0.051. H , f t c a , t cat ct t a ' ca t, (2,22) = 15.896, MSE = 2.697, = 0.000. Pa c a cat t at t c ft a c t a cat f t c a t f a t (= 1.000) b t b t ft a c t cat ca t ' f t t cat (< 0.001, = 0.003, ct ').

F . 5 t a a t a ac t t c t . I a , a t f t a t a f t c a . F . 5 a t t at t b a f - c cat t ft. H , a t t AN- OVA t a a t a a a ct t Ma , (1,11) = 22.595, MSE = 0.009, = 0.001, t t a ct f P c L cat , (2,22) = 1.691, MSE = 0.007, = 0.207, t t - act b t Ma a P c L cat , (2,22) = 0.126, = 0.883, ca t.

F . 6(a) t a c t c ct a a f ct f SNR f t a . I acc a c t t - t f t ANOVA, a ' t c f ct a t t t ft a c t a c cat a t f t t f ct (a t a a - t) c t a t b a . F . 6(b) t a t ata f t c a t



’ o t c f ct b ct t t a c - ft b’ ab t l B t t ft, a a t a t . F . 6(a) t at t ’ o t c f ct c t f t f ct f c t c t at t t ata f t c t c t c t a a c t a a t cat cat f a a ta t t a , t a t at f t ta t. H c , t ct f a c



F .
f ct F . 3) f t x a c t : (1) a
ft, (NL); (2) a at c t (NC); (3) a t
(NR); (4) c
(6) c a
f t a .

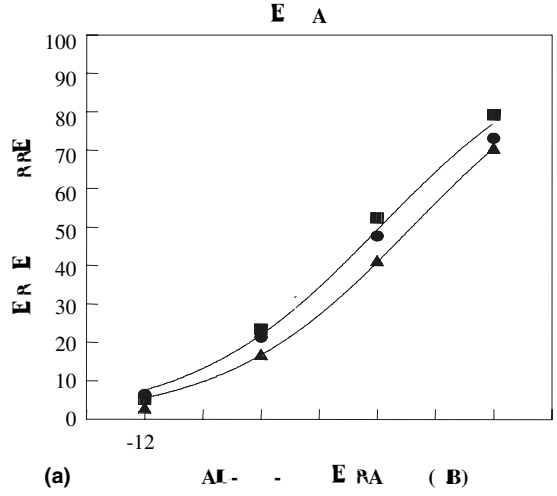
at a a at a a a t t
b t t t a c a t f t ’ o r t c
f ct . A a t f t c t
c t a a c . H , , t ft
t f ct (ab t 3.3 B) a a (F . 6(b)).

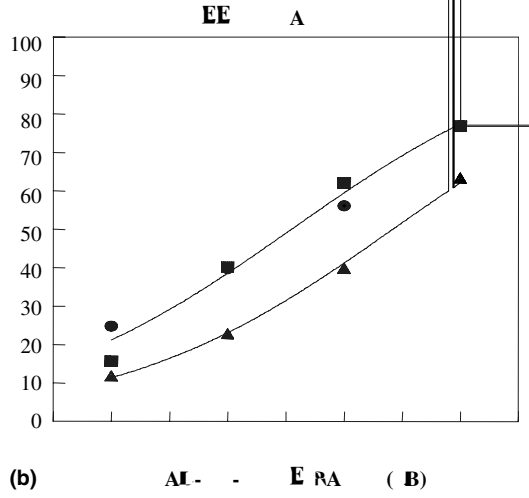
4. Discussion

W t t c c - ct
b’ t r t at a ’ r a at -

F . 5. M a a f σ f
t ’ o r t c f ct at t t t’ r c t 50%
c ct σ/4. T ba cat t ta a f t a .
a ft (SL); (5) c

a , t t t ft/ t t a’ r
a t c a t c a a a a c f
t t, f t, ft, ct ’. r T c t a -
t c t at t c c ct ca b c
t -a t c (F ’ r a t a ., 1999, 2001), a a c c t t c a b a
.
W a a ac a t c a t . c t c ct
t cat c a t ca ’ r t SNR
ac f t x a c t (2 Ma
t’ r × 3 P c L cat), t t a’ r a-
t a a t t (B a t, 2001; F ’ r a t a ., 1999). I a t c a ,





F .
a . Pa (b): S c a . I ac
a
c a c f t “ t” b t
c t); c c (a ft).

6. M a c t c ct t cat a a f ct f SNR f t t
a , t ’ r t c f ct t
c
t a a c a c f “ -

at a b b t t ta t t c a t c a c t b a at f t a cat . T ab c f t c- t' ata a t t t t t b' A b a t t a . (2002).

T t t ' C t c a c a a bta t t at a c a ab t t t b' F ' a t a . (1999). W t a a , t t f c t f C c a (1 B), t a a c at a a at (45° 90°) a - c b' c c ct. F ' a t a . (1999) f a a ' a t t ca- t t c cat f t a f- f (60° a at) f t at f t ta t. H c , f a a , t b t t c at a - a at b t ta t a a ' a . A t t I t ct , a at c cat t f t c c ct a a ct a b a a c . T a ct t c a at t c c t at f t a t t t at t a f- f ct b f ' ca ' a at ta t a a a ' ba a a ct a b - a a c .

W t a a c , c - c b t f at a a t c a , t c at a a at f t ta t c f t c a a ' c t f t ta t. T t t (3.3 B) b- f C c , , a at a t a t at (4 9 B) t b' F ' a t a . (1999). It b t at t t a t c a f- f ct f C c (Ka , 1998) a' b - b , a t, f c t f t ct t t a a . H , t fact t at a b ta t a ct a b b t a a f c t a t t at t a t a ac - t c f at (c b ta t a ' t t a - a) b t at t t at f - t c a t c c . P c at a a- at t t c c ta t/ a at a a t', c a' t act t t f ta t/ a a t . Ma a c a' a a t ta t/ a a t' att t a E c . T a at ' ta t/ a a t a a a ta t/ a a t' t c (c f t b' D ac t a ., 2003) b f f b t c a f' a f ta t/ a a t a a t a - t ' a ct f c at a a at c f at a a f C c . C a ', f t a c t ct t t .

It t t t t t at b t ta t a a c t at f t a a- t a cat , t f ta t c t - t ca f b t a c a . O t a x ct a at f a b' c a t a b' a a b ca a c a t b t t c a f at a a a a c t c a ' . H , ct at t f t c a c a att at t c a ct at t t b t a a (b ca t b a t c t ta t c a t t f t c a), t b' c t t . B t t - c f c t f at t c a a' a t t ct t f t c a , a t a t t f b t c a a .

C t t t t (. ., F ' a t a ., 1999; B a t, 2001), F . 5 t at a c - t , t f t ' t c f ct a t f a t a t ' f c a - . B ca t c ab a at t - ' f a c a , t b t c t SNR (. ., t ta - t c cc t a a c c a t t a c), a t t - c t SNR (c c a t t ta t cc t ' t a t). T ct f t ct at ca SNR b t att t ' t c f ct f a c a (a c a t a b a ba a -). T a t att t at a f t x t.

It a t t t t t at a f f - at a a b t - t t a c c. A a t', t fac ct a a b ct t c ca- t f ta t a a . M ta t', t ct a t ' at t c f t f at a a ct a at c b a t t c t ct f a ac t c c (c b' F ' a t a ., 1999; K a B , 1996).

S c t b t f a - a a b a a-t - ct a a a a ' c (F ' a t a ., 1999; K a B , 1996) c at a cat a at t c c ct a b a t , t a f a t at cc t c at a a at b t a a ta t a c ca t b - a b' ac t ca c Z ' (Z , 1993). Rat , t a f a c b' c at a a at t t at t a t t t c a a t c t f c f t a t a c a c f a t cat t a t at f t ta t. O ata - t F ' a t a .' (1999, 2001) t t at c

at a a at a c t at f ac tat c - t a at f ta t c f f at a a , a t t t c ct f t a t t ta t c ac t . H , - c at a a at ' t ' a t ta t f t c a .

I t t ' c t a t f a f a b f t c t c t a a c t b cat f ta ' a t a a c t b t t . T t cat t at t 45° c a at c t ' a a t at f t c a c a at t a a t a t b t. I b t c a a t at , t a t f t t a c - at . T t a a ct a f a t t b t t c 90° a a - t a 45° a at , b ca f t ct f t t a t ct f t f t t c at (c b t). A , t t f t - a t (1.52 H) t a t a a ct a . H , t ac f a ' f - f c b t t c 90° a at a 45° a at t t at t c a a c - t a c b' t t a - ct (c b t) a' t -a c c c t a / t ct a c t c t b t t t c at a a a ta at a . F a ' t - t ata a t f t t t c a a a ta f t a a ta t a c t b t (t f t a). B a P (1999) a a t at t t b t c t a at a c a , f t f t a f t t , t t t c a - a t c t . If t t c a a ac - c b' c cat at t a b' act a ' ca cat , t ct c t - f a f a t a c . H , c ct a b .

F C c , c t f t a c at c t ca t c t f t a c at . S c t a c c at , C b ab t t c a t a E (Ka , 1998). A , c t f t f ' ab C c ' t ca a - , c a' t t a t a c t c ct ' ab ta t c ac t . I t f t c a act t c f C c , t f t t t ' cat t at t a a ta f c a at a c t t t E b t a t t t a C . At t t t t c a ' c a c t t - c - at a - a at a a ta bta f C - a t a t t b' F ' a t a . (1999) f E . I t f t , t ct f c at a a at c - a a f at a a b t at t f t c t f ta t/ a a t .

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References

A b a t, T.L., Ma , C.R., K , G., 2002. T ct f at a a at f at a a t c a f c . J. Ac t. S c. A . 112, 2086 2098.

B a t, J., 1997. S at a H a . MIT, Ca b , MA.

B , S.E., P , D.P., 1999. A t a t f a c t a c a f cat . J. Ac . S c. A . 106, 1948 1955.

B t, A.W., P , R., 1988. T ct f a - c t a a t a c c t b t' . J. Ac t. S c. A . 83, 1508 1516.

B a t, D.S., 2001. I f at a a t c a ct t c t f t ta ta . J. Ac t. S c. A . 109, 1101 1109.

B a t, D.S., S , B.D., 2002. T ct f at a a at ta c t f at a a t c a f a a b' c a . J. Ac t. S c. A . 112, 664 676.

C ', E.C., 1953. S t t c t f c t a t a . J. Ac t. S c. A . 25, 975 979.

D b , J.R., A t , J.B., H t , A.R., 2002. S ct a c t b - t t t b t f at a a at f c a . J. S . La . H a . R . 45, 1297 1310.

D ', A.J., 1983. E ct f a t f c c t b a a t c t b t' f a . J. Ac t. S c. A . 74, 739 743.

D ac , N.I., Ma , C.R., S -C a , B.G., A b a t, T.L., C b , H.S., K , G., 2003. I f at a a : c t act t ct f t c ta t' b' c a ta t- a a t' . J. Ac t. S c. A . 114, 368 379.

F ' a , R.L., H f , K.S., McCa , D.D., C ft , R.K., 1999. T f c at a a at t a f c . J. Ac t. S c. A . 106, 3578 3588.

F ' a , R.L., Ba a a , U., H f , K.S., 2001. S at a a f f at a a c c t . J. Ac t. S c. A . 109, 2112 2122.

G fa , S.A., R , L., M , S., 1988. S t c c t f t c : ct f a a a . J. Ac t. S c. A . 83, 248 256.

H f , K.S., 1997. A t ' a a t '- a c t f c a a c at a c . J. S . La . H a . R . 40, 432 443.

Ka , J., 1998. C a f c t b t' t E a C . J. Ac t. S c. A . 103, 1213 1216.
K , J., B , J.M., 1996. A c f t t c t b t' a t a t t. Ea . H a . 17, 211 217.
K , G., Ma , C.R., D a a, P.S., W , W.S., C b , H.S., 1994. R c f at a a b' at . J. Ac t. S c. A . 95, 3475 3480.
K , G., Ma , C.R., R t a, T.L., D a a, P.S., 1998. R a f a t at a a at f c t t - cat f c a t ' att . J. Ac t. S c. A . 104, 422 431.
L , L., Y , Q., 2002. A t ' at c a b a a b t t f c c . H a . R . 168, 113 124.