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as precision in t n wou d ca brate attract t e counterpart events w t ower unct ona appropr ateness ro t e ot er oda t es ve r se to success u *multisensory integration* Dur n t e nte rat on u t sensory events w t n a presu ed s ort t e w ndow w ar e y obey t e assu pt on o un ty n w c t e co erent representat on o u t p e events beco e poss b e w en t ey ave been dee ed as co n ro a co on source ata s and pence M sceo and ay or C uen and c utz C en and pence As a resu t t e e ect veness o cross oda nteract on s en anced

However t e presu ed te pora w ndow or nte rat on as o ten been v o ated n any eco o ca scenar os a e an exa p e upon ear n t e w st e o a runn n car be nd us a ter a decent on de ay we can now exact y w at nd o t e car s approac n and t en a e pro pt avo dance s nd cates t at u ans can adapt ve y use t e pr or now ed e and e p oy t e te pora spat a n or at on nc ud n env ron enta cues assoc ated w t t e sound to ac tate t e perceptua dec s on s da y scenar o owever poses a reat c a en e or u an percept on How are perceptua roup n and correspondences between events ac eved w en t e cross oda events are separated bot n on er te pora ran es and w t ar er te pora d spar t es Moreover or t e on er te pora ran e observers ave d cu t es n e or z n a t e events and t e process n o t e sensory propert es nc ud n t e n or at on wou d probab y exceed t e r wor n e ory capac t es Cowan K e en et a K e en and C a bers Co en et a ere ore t e e c ency o cross oda nteract on w be reduced accord n y e co p ex t n scenar o as we as t e c a en e or t e co n t on a so ste s ro t e var ance

Here we extended t e ernus te pora ventr oqu s parad to nvest ate t e te pora cross oda ense b e cod n e p e ented ve exper ents to address t s ssue Exper ents and exa ned t e ro e o te pora w ndow nterva ap between t e o set o sound sequence and t e onset o tar et ernus d sp ay to s ow t e te pora constra nts o centra tendency e ect Exper ent co pared t e centra tendency e ect w t t e recency e ect by an pu at n bot t e ean aud tory nterva and t e ast aud tory nterva In Exper ent we xed t e ast nterva to be equa to t e trans t ona t res o d o perce v n e e ent vs roup ot on n t e pretest and an pu ated t e ean aud tory nter nterva to s ow a enu ne centra tendency e ect dur n cross oda ass at on In Exper ent we p e ented dua tas s and as ed observers to per or t e v sua ernus tas w e u n a concurrent tas o count n oddba sounds vera t e current resu ts revea ed t at cross oda centra tendency e ect s sub ect to t e te pora re erence nc ud n t e en t o oba t e nterva t e ean nterva and t e ast nterva or a ven sound sequence but ess dependent on attent ona odu at on

MATERIALS AND METHODS

Participants

A tota o part c pants n Exper ents a es ran n ro to years too part n t e a n exper ents A *post-hoc* power est at on as s own t e stat st ca powers are enera y approac n or above or t e ven sa p e s zes A observers ad nor a or corrected to nor a v s on and reported nor a ear n e exper ents were per or ed n co p ance w t t e nst tut ona u de nes set by t e Acade c A a rs Co ttee c oo o syc o o ca and Co n t ve c ences e n n vers ty e protoco was approved by t e Co ttee or rotect n Hu an and An a ub ects c oo o syc o o ca and Co n t ve c ences e n n vers ty A part c pants ave wr tten n or ed consent n accordance w t t e Dec arat on o He s n and were pa d or t e r t e on a bas s o CNY our e do ars our

Apparatus and Stimuli

e exper ents were conducted n a d y t u nance cd roo sua st u were presented at t e center o a nc C on tor FD at a screen reso ut on o × p xe s and a re res rate o Hz ew n d stance was c a nta ned by us n a c n rest A ernus d sp ay cons sted o two st u us ra es eac conta n n two b ac d scs cd d sc d a eter and separat on between d scs ° and o v sua an e respect ve y presented on a ray bac round cd e two ra es s ared one e e ent ocat on at t e center o t e on tor w e conta n n two ot er e e ents ocated at or zonta y oppos te pos t ons re at ve to t e center see **Figure 1A** Eac ra e was presented or s t e nter st u us nterva I I between t e two ra es was rando y se ected ro t e ran e o s w t a step s ze o s Mono sound beeps Hz pure tone dB L s except n Exper ent w ere pure tones w t p tc es o e t er Hz or Hz were ven were enerated and de vered v a an M Aud o card De ta to a eadset ps HM No ra ps were app ed to odu ate t e s ape o t e tone enve ope o ensure accurate t n o t e aud tory and v sua st u t e durat on o t e v sua st u and t e sync ron zat on o t e aud tory and v sua st u were contro ed v a t e on tor s vert ca sync ron zat on pu ses e exper enta pro ra was wr tten w t Mat ab Mat wor s Inc and t e syc op ys cs oo box Bra nard K e ner et a

Experimental Design

Practice

r or to t e or a exper ent part c pants were a ar zed w t ernus d sp ays o e t er typ ca e e ent ot on w t an nterva o s or roup ot on w t an nterva o s n a pract ce b oc ey were as ed to d scr nate t e two types o apparent ot on by press n t e e t or t e r t ouse button respect ve y e app n between response button and type o ot on was counterba anced across part c pants Dur n pract ce w en an ncorrect response was ade ed ate eedbac appeared on t e screen s ow n t e correct response e e e ent or roup ot on e pract ce sess on cont nued unt t e part c pant reac ed a ean accuracy o A part c pants ac eved t s w t n tr a s

Pre-test

For eac part c pant t e trans t on t res o d between e e ent and roup ot on was deter ned n a pre test sess on A tr a be an w t t e presentat on o a centra xat on cross ast n to s A ter a b an screen o s t e two ernus ra es were presented sync ron zed w t two aud tory tones e base ne I I sua = I I A ud tory t s was o owed by a b an screen o to s pr or to a screen w t a quest on ar pro pt n t e part c pant to a e a two a ternat ve orced c o ce response nd cat n t e type o perce ved ot on e e ent or roup ot on e I I between t e two v sua ra es was rando y se ected ro one o t e o ow n seven nterva s and s ere were tr a s or eac eve o I I counterba anced w t e t and r t tward apparent ot on e presentat on order o t e tr a s was rando zed or eac part c pant art c pants per or ed a tota o tr a s d v ded nto b oc s o tr a s eac A ter co p et n t e pre test t e proport ons o t e roup ot on responses across seven nterva s were tted to t e psyc o etr c curve us n a o st c unct on reutwe n and trasbur er c ann and H e trans t ona t res o d t at s t e po nt o sub ect ve equa ty E at w c t e part c pant was e y to report t e two ot on percepts equa y was ca cu ated by est at n o report n o roup ot on on t e tted curve e ust not ceab e d erence JND an nd cator o t e sens t v ty o apparent ot on d scr nat on was ca cu ated as a o t e d erence between t e ower and upper bounds o t e t res o ds ro t e psyc o etr c curve

Main Experiments

In t e a n exper ents t e procedure or present n v sua st u was t e sa e as n t e pre test sess on except t at pr or to t e occurrence o two ernus d sp ay ra es an

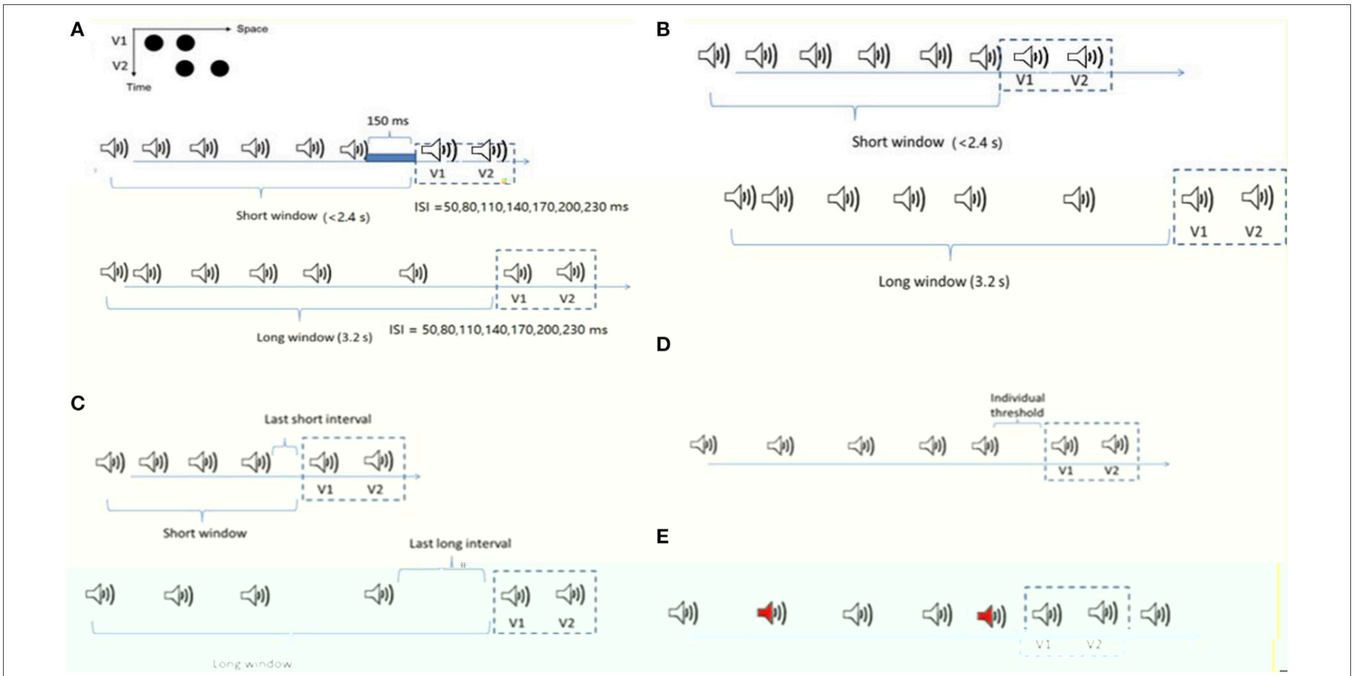

FIGURE 1 | Stimuli configurations for the four experiments. **(A)** Ternus display: two alternative motion percepts of the Ternus display—"element" motion for the short ISIs, with the middle black dot perceived as remaining static while the outer dots are perceived to move from one side to the other. "Group" motion for long ISIs, with the two dots perceived as moving in tandem. The auditory sequence consisted of 6 to 8 beeps (with 7 beeps as the most frequent cases). The Ternus display, with 50 to 230 ms interval between the two frames, was followed by a blank interval of 150 ms to the offset of the last beep in the short time window condition (the total interval length from the onset of the first beep to the onset of the first visual Ternus frame was less than 2.4 s), and 3.2 s in the long time window condition. In both the short and long window conditions, two beeps were synchronously paired with two visual Ternus frames. **(B)** The configuration was nearly the same as in **(A)**, but for the short window condition, the two frames followed immediately with the last beep. **(C)** The competition between the mean interval in temporal window and the last auditory interval upon the visual Ternus motion. The mean auditory inter-intervals/last auditory intervals could be longer (transition threshold + 70 ms) or shorter (transition threshold −70 ms) than the threshold between the element—and group—motion percept. The lengths for both short and long time windows were the same as in **(A)**. **(D)** Two types of auditory sequences with five auditory intervals were composed: one with its geometric mean 70 ms shorter than the transition threshold of the visual Ternus motion ("Short" condition), and the other with its geometric mean 70 ms longer than the transitional threshold ("Long" condition). The last auditory interval before the onset of Ternus display was fixed at the individual "transitional threshold" for both sequences. **(E)** The configuration was similar as in C but the sound sequence had up to two oddball sounds (500 Hz, here we showed two oddball sounds with red labels). The remaining regular sounds were of 1,000 Hz (including the two beeps synchronous with the two visual frames).

aud tory sequence cons st n a var ab e nu ber o / beeps was presented see be ow or t e deta s o t e onset o ernus d sp ay ra es re at ve to t at o t e aud tory sequence A tr a be an w t t e presentat on o a centra xat on ar er rando y or to s A ter a s b an nterva t e aud tory tra n and t e v sua ernus ra es were presented see **Figure 1A** o owed sequent a y by a b an screen o to s and a screen w t a quest on ar at t e screen center pro pt n part c pants to nd cate t e type o ot on t ey ad perce ved e e ent vs roup ot on non speeded response Dur n t e exper ent observers were s p y as ed to nd cate t e type o v sua ot on e e ent or roup ot on t at t ey perce ved w e nor n t e beeps A ter t e response t e next tr a started o ow n a rando nter tr a nterva o to s

In Exper ent t e v sua ernus ra es were preceded by an aud tory sequence o / beeps w t t e eo etr c ean o nter st u us nterva IA ud tory e IA an pu ated to be s s orter t an or s on er t an t e trans t on t res o d est ated n t e pre test e I sua e I between t e two v sua ernus ra es was rando y se ected ro one o t e o ow n seven nterva s / and s e tota aud tory sequence cons sted o / beeps sua ernus ra es were presented on ost o a tr a s tr a s n tota o ow n t e ast beep t e re a n n were catc tr a s tr a s n w c t e ra es were nset n t e sound sequence to brea up ant c patory processes For t e s ort t e w ndow o t e aud tory sequence t e t e nterva ro t e onset o t e rst beep to t e onset o t e rst v sua ra e was ess t an s and t e ap nterva between t e o set o t e ast beep and t e onset o t e rst ernus ra e was s For t e on t e w ndow t e tota nterva ro t e onset o t e sound to t e rst v sua ra e was s In bot t e s ort and on w ndow cond t ons two beeps were sync ronous y pa red w t two v sua ernus ra es A t e tr a s were rando zed and or an zed n b oc s tr a s or eac b oc

In Exper ent t e sett n s were t e sa e as n Exper ent except or t e cond t on t e v sua ra es were o ow n ed ate y w t t e o set o t e ast beep

In Exper ent we ntroduced two actors o nterva odu at ons t e ean nterva o te pora w ndow and t e ast aud tory nterva e ean aud tory nter nterva s and t e ast aud tory nterva s cou d be ar er trans t on t res o d + s or s orter trans t on t res o d − s t an t e t res o d between t e e e ent and roup ot on percept ere ore t ere were our co b nat ons o t e nterva cond t ons bot t e ean nterva and t e ast nterva were s orter e MeanLast t e ean nterva was s orter but t e ast nterva was on er MeanLastL t e ean was on er but t e ast nterva was s orter MeanLLast and bot t e ean nterva and t e ast nterva were on er MeanLLastL e onset o t e two v sua ernus ra es s was acco pan ed by a s aud tory beep e I I = I I A

In Exper ent we co pared two aud tory sequences one w t ts eo etr c ean s s orter t an t e trans t on t res o d o t e v sua ernus ot on erea ter t e ort cond t on and t e ot er w t ts eo etr c ean s on er t an t e trans t ona t res o d erea ter t e Lon cond t on Instead o rando zat on o t e ve aud tory nterva s exc ud n t e na sync ronous aud tory nterva w t t e v sua ernus nterva t e ast aud tory nterva be ore t e onset o ernus d sp ay was xed at t e trans t ona t res o d or bot sequences e rest our nterva s were c osen rando y suc t at t e coe c ent o var ance C o t e aud tory sequence was n t e ran e between and w c s t e nor a ran e o C or u an observers A an Getty enney et a By t s an pu at on we expected to n ze t e n uence o t e potent a recency e ect caused by t e ast aud tory nterva e aud ov sua ernus ra es were appended at t e end o t ese sequences or tr a s w t tr a s out o tr a s n w c t e ernus d sp ay appeared at t e end o t e sound sequence t e onset o rst v sua ra e was sync ron zed w t t beep e re a n n were catc tr a s n w c tr a s ad t e ernus d sp ays at t e be nn n o t e sound sequence e t e onset o t e rst v sua ra e was sync ron zed w t t e second beep and t e rest tr a s at d e te pora ocat ons e t e onset o t e rst v sua ra e was sync ron zed w t t e t beep ose catc tr a s were used to avo d potent a ant c patory attend n to t e v sua events appear n at t e end o t e sound sequence e tota tr a s were rando zed and or an zed n b oc s w t eac o tr a s

In Exper ent we used t ree types o aud tory sequences n w c t e ean aud tory nterva was e t er *shorter than equal to* or *longer than* t e nd v dua trans t ona t res o d o ernus ot on e aud tory sequence cons sted o to beeps nc ud n t ose acco pany n t e two v sua ernus ra es w t t e atter be n nserted a n y at t e t − t pos t ons tr a s and o owed by beeps nu ber se ected at rando to n ze expectat ons or t e onset o t e v sua ernus ra es wo o t e beeps t e t and t e t were sync ronous y pa red w t two v sua ernus ra es w c were separated by a v sua I I I I t at var ed ro to s or t e cr t ca beeps I I = I I A ere were up to two oddba tones Hz n t e sound sequence w e t e re a n n re u ar sounds were o Hz nc ud n t e two beeps sync ronous w t t e two v sua ra es art c pants co p eted a dua tas n w c t ey not on y ade d scr nat ons o t e ernus d sp ay e e ent ot on vs roup ot on but a so reported t e nu ber o oddba sounds **Figure 1**

RESULTS

Experiment 1: The Effect of Short Temporal Window (With a Temporal Gap Between Auditory Sequence and Visual Ternus) vs. Long Temporal Window

e Es or t e s ort w ndow and on w ndow were ± standard error s and ± s e a n e ect o te pora w ndow was s n cant $F = $ $p =$ $\eta_g =$ e Es or s ort nterva and on nterva were ± s and ± s t e a n e ect o ean nterva was not s n cant $F =$ $p =$ $\eta_g =$ e nteract on e ect between actors o w ndow and nterva was not s n cant $F =$ $p =$ $\eta_g =$ For t e JNDs bot t e a n e ects o te pora w ndow and ean nterva were not s n cant $F =$ $p =$ $\eta_g =$ and $F =$ $p =$ $\eta_g =$ And t e nteract on e ect between t e two actors was not s n cant $F =$ $p =$ $\eta_g =$ **Figures 2 4**

Experiment 2: The Effect of Short Temporal Window (Without a Gap Between Auditory Sequence and Visual Ternus) vs. Long Temporal Window

e Es or t e s ort w ndow and on w ndow were ± s and ± e E or s ort w ndow was ar er

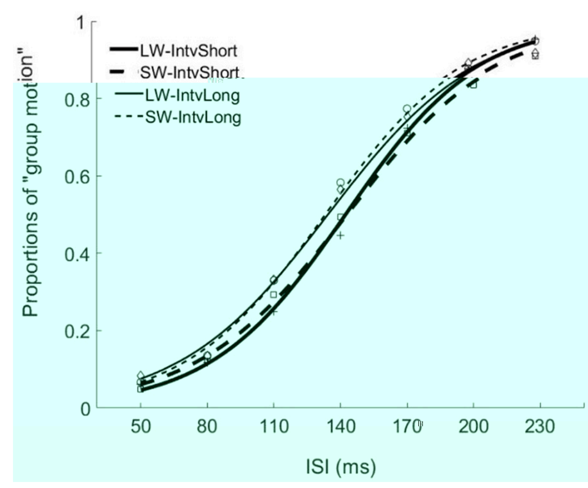

FIGURE 2 | Psychometric curves for Experiment 1. Mean proportions of group-motion responses were plotted as a function of the probe visual interval (ISIv), and fitted psychometric curves, were plotted for the auditory sequences with the different lengths of temporal windows and with different (geometric) mean intervals relative to the individual transition thresholds. SW-IntvLong, Short window with long mean auditory inter-interval; SW-IntvShort, Short window with short mean auditory inter-interval; LW-IntvLong, Long window with long mean auditory inter-interval. LW-IntvShort, long window with short mean auditory inter-interval.

t an t e one n on w ndow F = / p = η_g = e Es or s ort nterva and on nterva were ± s and ± / t e a n e ect o ean nterva

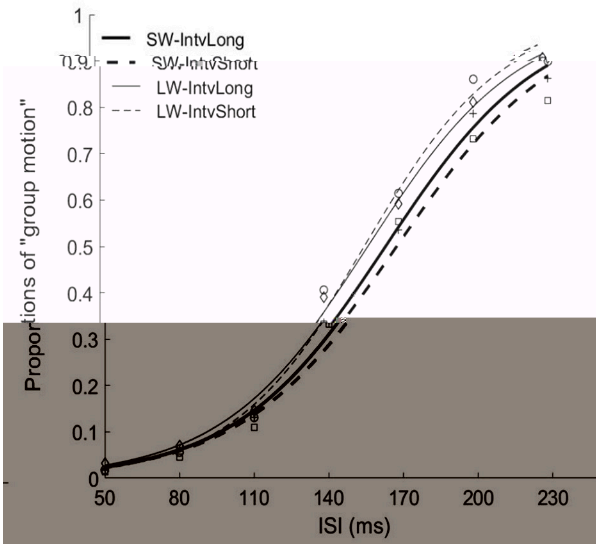

FIGURE 3 | Psychometric curves for Experiment 2. SW-IntvLong, Short window with long mean auditory inter-interval; SW-IntvShort, Short window with short mean auditory inter-interval; LW-IntvLong, Long window with long mean auditory inter-interval. LW-IntvShort, long window with short mean auditory inter-interval.

was not s n cant F = / p = η_g = I portant y t e nteract on e ect between actors o w ndow and nterva was s n cant F = p = η_g = / Furt er s p e ect ana yses s owed t at or s ort nterva t e E n s ort w ndow ± s was a er t an t e one ± s n on w ndow p = For on nterva t e E n s ort w ndow ± s was a er t an t e one ± s n on w ndow p = n t e ot er and or t e s ort w ndow t e E n s ort nterva ± s was a er t an t e one n on nterva ± s p = However or t e on w ndow t e Es are equa n bot nterva s vs s or s ort and on nterva s p =

For t e JNDs bot t e a n e ects o te pora w ndow and ean nterva were not s n cant F = p = η_g = and F = / p = η_g = e nteract on e ect between t e two actors was not s n cant F = / p = η_g = **Figures 3**, **4**

Experiment 3: Central Tendency Effect vs. Last Interval

e Es or t e s ort ean nterva and on ean nterva were ± s and ± e a n e ect o ean nterva was s n cant F = p = η_g = e Es or s ort ast nterva and on ast nterva were / ± s and ± s respect ve y e a n e ect o ast nterva was s n cant F = p = η_g = e nteract on e ect between actors o ean nterva

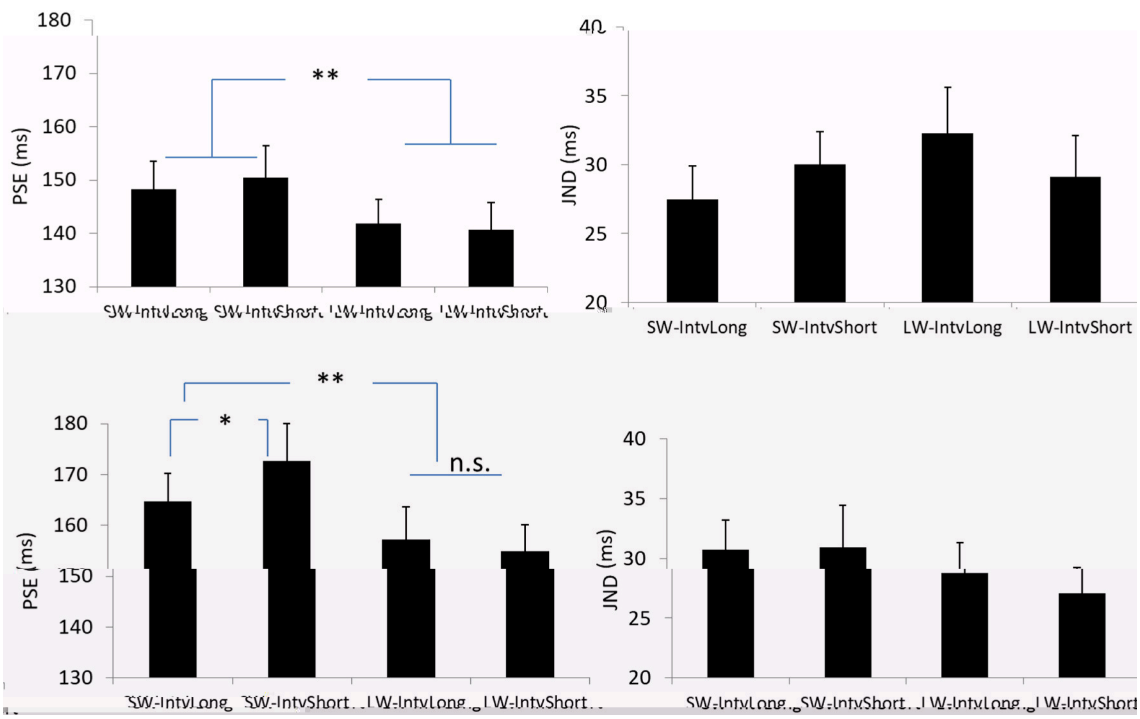

FIGURE 4 | Plotted bars for PSE (point of subjective equality) and JND (just noticeable difference) for Experiments 1 **(Upper)** and 2 **(Down)**. *p < 0.05, **p < 0.01, n.s. not significant.

and ast nterva was not s n cant F = , p = , ηg = . For t e JNDs t e JND n s ort ast nterva ± s was a er t an t e one n on ast nterva ± s F = , p = , ηg = . However t e a n e ect o ean nterva was not s n cant F = , p = , ηg = . e nteract on e ect between t e two actors was a so not s n cant F = , p = , ηg = Figures 5, 6 .

Experiment 4: Central Tendency Effect but With the Last Interval Fixed

Here we ade or a an pu at on by eep n t e ast nterva xed or t e ort and Lon aud tory sequences Figure 7 dep cts t e responses ro a typ ca part c pant e Es were ± ± or t e ort and Lon cond t ons, t = , p < art c pants perce ved ore do nant percept o E ent ot on n t e ort cond t on t an n t e Lon cond t on, cons stent w t t e nd n s o t e prev ous exper ents at s t e aud tory ense b e ean st ass ated v sua ernus apparent ot on w en t e ast nterva o t e aud tory sequence was xed ere ore t e aud ov sua nteract ons we ound were un e y on y due to t e recency e ect

Experiment 5: Central Tendency Effect With Attentional Modulation

e Es or t e *baseline, short, equal,* and *long* nterva s were ± ± and ± s t e a n e ect o ean nterva was s n cant F = , p < , ηg = . Bon erron corrected co par son s owed t at t e E or base ne was s a er t an t e one n s ort cond t on, p = , E or s ort nterva cond t on was a er t an t e one n equa cond t on, p = and t e E or s ort nterva was a so a er t an t e ones n t e equa and on nterva s, p = and p = . However t e Es were equa or bot

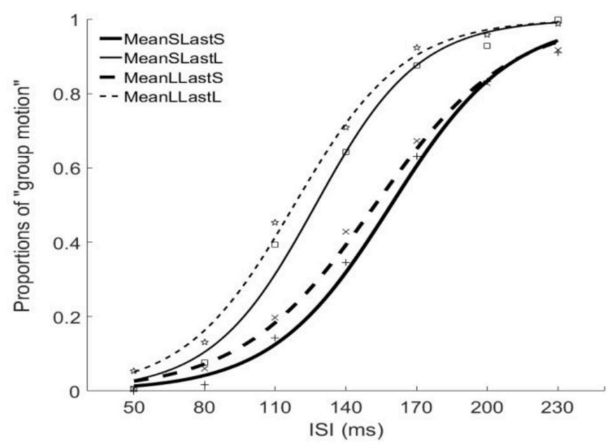

FIGURE 5 | Psychometric curves for Experiment 3. MeanSLastS (bold solid line), Mean short interval with long last auditory interval; MeanSLastL(thin solid line), Mean short interval with short last auditory interval; MeanLLastS(bold dashed line), Mean long interval with short last auditory interval; MeanLLastL(thin dashed line), Mean long interval with long last auditory interval.

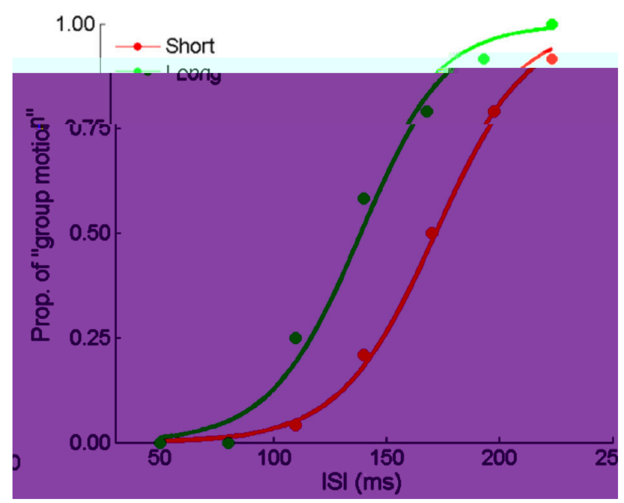

FIGURE 7 | Mean proportions of group-motion responses from a typical participant are plotted against the probe visual interval (ISIv), and fitted psychometric curves for the two geometric mean conditions: the "Short" sequence (with the smaller geometric mean) and "Long" sequence (with the larger geometric mean) in Experiment 4.

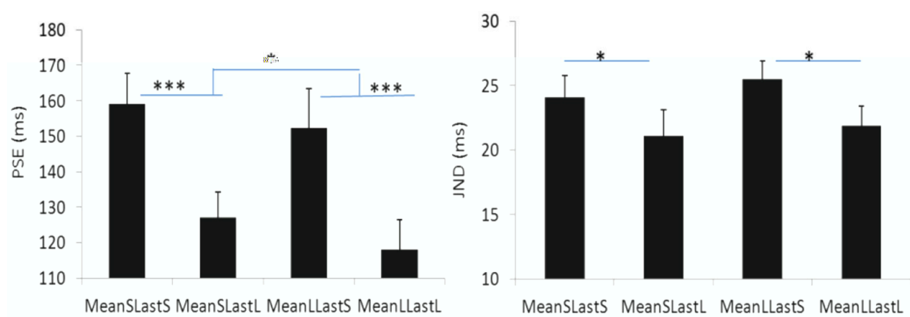

FIGURE 6 | Plotted bars for PSE (point of subjective equality) and JND (just noticeable difference) for Experiment 3. *$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$.

equa and on cond t ons, $p =$ e Es were equa or bot base ne and equa cond t on, $p =$ and were equa between base ne and on cond t ons, $p =$

e JNDs or t e *baseline, short, equal,* and *long* nterva s were ± ± ± and ± s, respect ve y e a n e ect o ean nterva was not s n cant, $F = $, $p =$, $\eta_g =$ **Figures 8, 9**

e ean correct rate or report n t e nu ber o oddba sounds was ± one sa p e *T* test w t co par son o s owed t e correct rate was above t e c ance eve $t =$, $p =$ ×

DISCUSSION

Centra tendency, t e tendency o ud ents o quant tat ve propert es en t s, durat ons etc or ven st u to rav tate toward t e r ean, s one o t e ost robust perceptua e ects e present study as s own t at perceptua avera n o te pora property aud tory nterva s ass ates t e v sua nterva between t e two ernus d sp ay ra es, and b ases t e percept on o ernus apparent ot on e t er to be do nant e e ent ot on or do nant roup ot on s nd n s cons stent w t t e ar e body o terature on te pora context and centra tendency e ects, w t n t e broader ra ewor o Bayes an opt zat on Jazayer and ad en, et a oac et a, w ereby ncorporat n t e ean o t e stat st ca d str but on n t e est at on wou d ass ate t e est ates toward t e ean nown as centra tendency e ect Jazayer and ad en, Burr et a, Kara n s et a

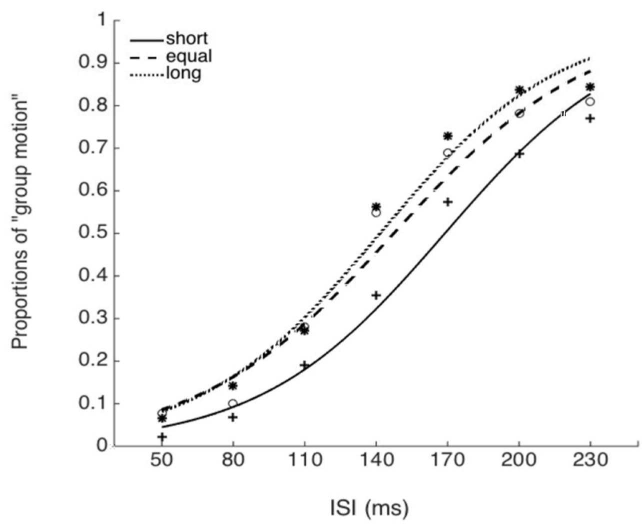

FIGURE 8 | Psychometric curves for Experiment 5. Short (solid line), the mean auditory inter-interval is shorter than the PSE for visual Ternus motion; Equal (dashed line), the mean auditory inter-interval is equal to the PSE for visual Ternus motion; Long (dotted line), the mean auditory inter-interval is longer than the PSE for visual Ternus motion. The PSE ("transitional threshold") of Ternus motion was established by a pre-test for each individual.

By us n t e parad o te pora ventr oqu s and t e probe o v sua ernus d sp ay C en et a et a C en and roo en, we ave prev ous y s own t at t e aud tory capture e ect upon t e v sua events, n w c t e perce ved v sua nterva was b ased by concurrent y presented aud tory events bservers tended to report t e usory v sua apparent ot on percepts w t t e concurrent presence o aud tory beeps However, t e v sua aud tory nte rat on e ect s sub ect to t e te pora re erence, e, t e t e nterva between t e cr t ca v sua probe and t e sound sequence, t e ean aud tory nterva and t e cr t ca nterva between t e ast aud tory st u us and t e onset o v sua events In our current sett n, w en t e tota t e nterva between t e onset o aud tory s na and t e onset o v sua events was above s, t ave r se to a d n s ed centra tendency e ect n t e contrary, w en t s t e nterva was ess t an s, t e s ortened t e re erence ncreased t e e ood o centra tendency e ect ater a zed n t e e ect o eo etr c perceptua avera n or aud tory nterva s upon t e v sua ernus ot on ese nd n s nd cate a enera te pora ra ewor o cross oda nte rat on As stated n a t eoret ca construct o te pora percept on, nown as t e sub ect ve present a ec an s o te pora nte rat on b nds success ve events nto perceptua un ts o durat on . ppe uc a te pora nte rat on, w c s auto at c and pre se ant c, s a so operat ve n ove ent contro and ot er co n t ve act v t es In t s erarc ca te pora ode t e te pora re erence or te pora b nd n cou d be extended but ted w t n , to et er w t a e ory store . ppe . ppe and Bao, en t e ra ewor exceeds , t e nte rat on o t e preced n aud tory nterva n or at on cou d be decayed, w c ence a es t e aud tory ass at on e ect reduced

Interest n y, even w t t e presu ed s ort te pora w ndow w t n s by nsert n a s ort te pora ap s between t e o set o t e very ast beep and t e onset o t e rst v sua ra e, we ound t e centra tendency e ect was reduced, and t e e ect was s ar to t e resu ts n on te pora w ndow cond t on s s nd n su ests t at t e nent and ost recent ed ate te pora ap be ore t e tar et v sua event s cr t ca or t e deve op ent o t e centra tendency e ect s n erence s urt er substant ated by t e resu ts ro Exper ents and In Exper ent , w t t e con urat on o s ort w ndow, we e nated t e s ort ap s between t e o set o t e ast beep and t e onset o t e v sua ra es e ound t at t e centra tendency e ect s ort ean nterva vs on ean nterva reappeared, t ou t st re a ns absent n t e cond t on o on w ndow. Moreover, n Exper ent , we urt er ound t at t e ass at on e ect o t e ast nterva do nates t at o t e ean aud tory nterva s nd cates t at t e ast aud tory nterva w ns t e co pet t on over t e ean nterva n dr v n t e cross oda ass at on

However, t e centra tendency e ect was ess dependent on attent ona odu at on s n t e dua tas s o report n t e percept o v sua ernus ot on and t e nu ber o oddba st u e, dent y n t e nu ber o Hz beep s w t n a sound sequence, we a a n ound t e centra tendency e ect was robust e observers ave nvested ar e attent ona resources to

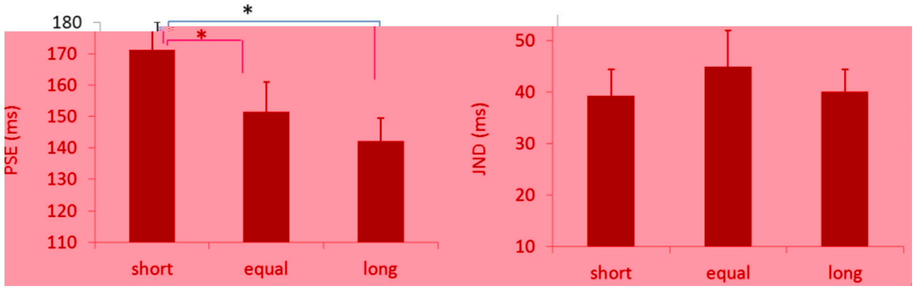

FIGURE 9 | Plotted bars for PSE (point of subjective equality) and JND (just noticeable difference) for Experiments 5, *$p < 0.05$.

obta n t e decent per or ance o count n⊠ t e oddba sounds Nevert e ess t e per or ance o cross oda ass at on e ect st surv ved ere ore t e centra tendency e ect as s own n t e present study as de onstrated ts auto at c and attent ona ess de and n⊠ nature dur n⊠ cross oda nteract on roo en et a ⊠ a n and Kon ⊠ ⊠

e current study as so e tat ons Indeed t e te pora re erence be ore t e tar⊠et v sua ernus d sp ay nc udes nterva s co posed by st u w t d erent con⊠urat ons e aud tory sequence was or⊠an zed by ed durat ons w t u t p e beeps and t ere was a trans t on o ntra oda perceptua ⊠roup n⊠ w t sounds⊠ to cross oda ⊠roup n⊠ w en t e ast beep was o owed by t e onset o t e rst v sua ernus ra e w t aud ov sua events⊠ Burr et a ⊠ However t e cr t ca t e w ndow or u t sensory nte⊠rat on was presented as an e pty nterva between t e two v sua ra es ere ore t e v sua probe we adopted n current exper enta parad ⊠ ⊠ t restr ct t e an estat on o ass at on e ect w c was probab y due to t e d erent a t n⊠ sens t v t es to t e ed durat on n aud tory sequence vs e pty durat on n t e v sua probe a sayer and L a ⊠Grond n ⊠ a sayer ⊠ Moreover t e te pora w ndow as s own n t e aud tory sequence covar ed w t t e ean I⊠Is ean aud tory nterva s⊠ s potent a con ound re a ns even a t ou⊠ we ave an pu ated t e co par sons o durat ons between t e ean I⊠Is and t e cr t ca nterva between t e two v sua ra es Exper ents and ⊠ and tr ed to tease apart t e centra tendency e ect vs recency e ect by x n⊠ t e ast nterva s Furt er researc s needed to e uc date t s po nt

a en to⊠et er t e current study as s own t at cross oda ass at on n te pora do a n s s aped by t e te pora re erence n w c t e observers use t e te pora n or at on by dyna ca y avera⊠ n⊠ t e nterva s as t ey un o d n t e sequence⊠ and exp o t n⊠ t e ast nterva be ore t e tar⊠et events e centra tendency e ect n te pora do a n s ar to t e centra e ect assoc ated w t ot er sensory propert es suc as we⊠ ts and ues s adapt ve y sub ect to t e ra e o re erence Ho n⊠wort ⊠He son ⊠He son and H e ste n ⊠ er et a ⊠ o as and Jones ⊠He son and Avant ⊠ o as et a ⊠ Hebert et a ⊠ o as and ⊠trub ⊠New n et a ⊠Burr et a ⊠Kara n s et a ⊠ I portant y t e te pora n or at on near t e tar⊠et event s cr t ca or cross oda ass at on w ere n t e recency e ect preva s over t e centra tendency e ect dur n⊠ t e ass at on process Burr et a ⊠Kara n s et a ⊠ Cross oda ass at on s ore dependent on t e te pora durat on w c enta s t e nte⊠rat on o tas re evant te pora ⊠ n or at on to be e c ent w t n a s ort w ndow ⊠ n add t on to e c ent wor n⊠ e ory unct ons ppe ⊠B oc and Gruber ⊠ ppe and Bao ⊠ However t e cross oda ass at on s ess sub ect to anot er process attent ona odu at on a s a et a ⊠

AUTHOR CONTRIBUTIONS

Y conducted Exper ent and ana yzed data LC conducted Exper ents ana yzed data and wrote t e anuscr pt

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SUPPLEMENTARY MATERIAL

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